SERVICE INFORMATION
PHYACTION 190 / 190i

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Phyaction is manufactured in The Netherlands by Uniphy BV
P.O.Box 558 , NL-5600 AN Eindhoven, the Netherlands
Tel. +31 499 491800 Fax. +31 499 474734

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CHAPTER 1 GENERAL INFORMATION

1.1 Introduction

The Phyaction 190 is an appliance for ultrasound therapy and it can be used for combination therapy with an external electrotherapy appliance.

In this chapter the important features from the users manual for service personnel are listed. In the next chapter the theory of operation will be explained. In chapter 3 is described how service personnel can check the operation of the Phyaction 190 and what maintenance operations should be carried out. The next chapter contains information which could be very useful for trouble shooting such as a description of the automatic self test and a list of the error numbers. The operations that have to be carried out if you want to exchange a printed circuit board or another module are described in chapter 5.

1.2 Safety aspects

1.2.1 Electrical safety

The equipment can only be used in areas with provisions in accordance with current statutory requirements. Pay particular attention to the use of protective earth, otherwise the patient leakage current can rise above the permitted limit for type BF equipment.

1.2.2 Explosion safety

The equipment is not suitable for use in areas where flammable gasses or vapours are present. Therefore, remove the mains plug from the socket before the area in which the equipment is located is disinfected, since some disinfection solutions evaporate and subsequently form an explosive mixture.

1.2.3 Operational safety

- Using the equipment in the vicinity of short wave or microwave equipment can influence the correct operation of the unit. Using this equipment when high frequency surgical equipment is connected to the patient at the same time can result in burning under the electrodes when using it for combination therapy.
- Patients who have electrical implants (i.e. pacemaker) may only be treated following medical advice.
- The equipment is not suitable for use in damp areas.
- The equipment may not be disinfected or sterilized.
- Whenever the equipment is switched on (using the main switch) the microprocessor checks the entire system for correct operation.
- The ultrasound heads, including the cable and the connectors should be checked regularly. In particular attention should be paid to damage to the ultrasound heads through which liquids can enter the ultrasound heads.
- The ultrasound heads should be handled carefully, because the properties of the ultrasound heads can alter due to rough handling.

1.2.4 Use of the appliance

The equipment and accessories should only be used by authorized personnel and in accordance with all instructions included in these operating instructions.
The Phyaction 190 is only to be used for providing ultrasound therapy. When connected to an electrotherapy appliance the Phyaction 190 can be used to provide combination therapy.

1.2.5 Radio interference suppression and electromagnetic compatibility

This equipment meets the guidelines for ISM equipment relating to electromagnetic compatibility and is radio interference suppressed according to EN55011. Also see section 1.2.3 *Operational safety* of this chapter, concerning the use of the equipment in the vicinity of short wave and microwave equipment.

1.3 Installation

1.3.1 Incoming inspection
Check that the equipment and ultrasound head(s) have not been damaged during transportation and that the accessories are intact and complete (see chapter 14 ACCESSORIES of the INSTRUCTIONS FOR USE). In the event of damage and/or defect you should inform your supplier.

1.3.2 Mains voltage
Your equipment is suitable for a nominal voltage of 110, 220, 230 or 240 Volt AC, 50-60 Hz. Indicated on the rear of the equipment will be the voltage for which it has been wired. You can not alter this yourself. Carefully check this data before you place the mains plug in the socket. The mains input is on the back of the appliance at the bottom.

1.3.3 Functional test
During production the equipment is tested for electrical safety. Whenever the equipment is switched on, the processor performs an extensive test to ensure that the equipment is operating correctly. In addition you must check whether the display and the indicator lamps are operating correctly. The green lamp indicates that the appliance is connected to the mains supply and that the appliance is switched on. The red lamp illuminates when the safety system has detected a fault which prevents the appliance being used. If the appliance is not operating correctly, then you must not use the equipment and you must contact your supplier.
If you can not read or if it is difficult to read the display, then press the right hand blue button and the black ⮝ button in order to darken the text or the black ⮟ button if you want to make the text lighter.

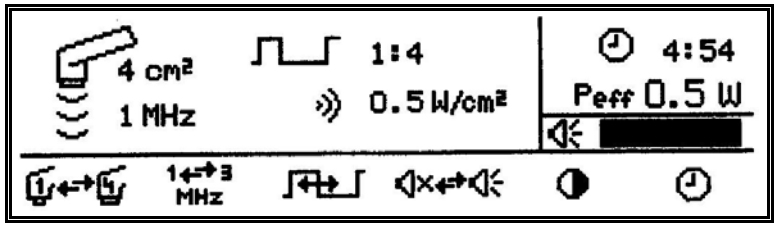
1.3.4 Location and transportation
The equipment must be set up horizontally and stable. You should ensure that the vents in the housing are not blocked so that circulation of air is not hindered. Objects must not be placed on the equipment and you must ensure that no liquid enters the equipment.

1.3.5 Fitting the head holder
As standard, a head holder is supplied with each treatment head. Before you use the Phyaction 190 for the first time, we advise you to fix the head holder(s) to the appliance. The ultrasound treatment head can be connected to the appliance easily and in a user-friendly manner into the head holder. At the same time this protects the treatment head against damage by, for example, falling.
For a description of fixing the head holder to the appliance please refer to the drawing which you will find in the packing for the head holder.

1.3.6 Checking the ultrasound heads
You can check which head belongs to which appliance by pressing the yellow button for 3 seconds. In the middle of the screen which then appears, you will see the treatment head symbol with a statement of the ERA on which treatment head(s) the appliance has been tuned. After this symbol there are 20 figures. If these figures correspond exactly with the figures on the treatment head label then this treatment head belongs to that appliance. If they do not correspond, you are using a treatment head which does not belong to that appliance. If the middle screen is completely empty then the appliance has not been tuned to any treatment head and we advise you to inform your supplier.

1.4 Description of the controls
On the last page of this operating instruction you will find an illustration of the equipment and the accessories.

1.4.1 Display
The display[1] consists of separate picture elements which are controlled by a processor so that you can see text and figures. When you are performing a treatment, the display shows all of the information you require:
- The top left section provides information about the parameters which have been set.
- The right section provides information about the output power and the degree of contact of the treatment head. This section also gives information about the treatment time.
- The bottom line of the display shows the functions of the blue buttons.



Lay-out of the therapy screen

1.4.2 Signal lamps

On the front, to the right of the display, there are two coloured lamps:

- The green lamp[2] indicates that the appliance is connected to the mains supply and that the appliance is switched on.
- The red lamp[3] illuminates when the safety system has detected a fault which prevents the appliance being used. A message appears on the display. See chapter 4 TROUBLE SHOOTING. The red lamp also illuminates during the self test which is performed after switching on the appliance.

The yellow lamps[4], beside the output connectors of the ultrasound head, illuminate for 2 seconds as soon as the relevant ultrasound head has been selected. A yellow lamp also illuminates beside an output connector as soon as ultrasound power is emitted.

1.4.3 Rotary knob

On the right-hand side at the front there is a large rotary knob[5] with which the intensity peak in Watt/cm^2 can be adjusted. When you rotate this knob fully anti-clockwise you will feel a click and it is in the zero position.

1.4.4 Push buttons

- Using the blue buttons [6] a parameter can be selected. This display clearly shows the function of the buttons.
- The black buttons ▲ or ▼[7] are used to increase or decrease the value of a parameter which you have already selected.
- The yellow button[8] is used to return to the therapy screen. When the yellow button is depressed for 3 seconds, a screen appears in which the software version number, the release date of the software and the treatment head parameters can be read.
- Using the green button[9] you can access the special memory function. 20 different treatments can be saved, retrieved or changed.

1.4.5 Output connectors and sockets on the front

- The safety socket[10] on the far left is used for connecting the electrode cable during combination therapy. The metallic treatment surface of the ultrasound head forms the other electrode.
- The ultrasound head(s) are connected to the two connectors[11] on the right. It makes no difference which head(s) you connect to which connector. Two treatment heads can be connected at the same time provided they do not have the same format.

1.4.6 Controls on the bottom at the rear of the appliance

The following controls can be found on the rear of the appliance:

- The mains input with mains switch[12].
- The fuse holder[13] is located between the mains input and the mains switch. The rating of the fuse to be used is stated on the rear of the appliance.
- The connector for connecting to the potential equalization busbar[14].

1.4.7 Label on the rear of the appliance

The label containing the appliance data[15] is located on the rear of the appliance.

1.4.8 Ultrasound treatment heads

You have the choice of two ultrasound treatment heads[16] with an ERA (Effective Radiating Area) of either 1 cm^2 or 4 cm^2. The treatment heads can be easily located in the multi-functional head holder[17]. With each treatment head both 1 MHz and 3 MHz ultrasound can be applied. Both treatment heads can be connected to the appliance at the same time. Using the blue button you can select which you want to use.

The display indicates which format of treatment head has been selected at that moment. As soon as the Phyaction 190 is switched on using the mains switch or from the stand-by position, or as soon as a treatment

head has been selected, the yellow lamp beside the selected head illuminates for 2 seconds on the appliance. Furthermore, each treatment head has a colour indication at two positions: the 4 cm^2 treatment head is green and the 1 cm^2 is yellow.
When the surface of the treatment head makes insufficient contact with the patient this is shown on the screen. The ultrasound power is then automatically turned down so that overheating of the treatment head and subsequent wear is reduced. The treatment time also stops when there is insufficient contact and this starts again as soon as contact is re-established. In this way the set time is actually utilized.
The appliance should always be tuned to the associated treatment heads. For every new appliance the heads are already tuned to the appliance. However, when a new (another) treatment head is purchased, the appliance should be tuned to the new head. When you press the yellow button for 3 seconds, a screen appears in which you can check whether you are using the correct treatment heads with the appliance. In Appendix 2 TUNING THE ULTRASOUND TREATMENT HEADS, the tuning process is described.

1.4.9 Head holder
For each Phyaction 190 a head holder for each treatment head is supplied as standard. You can fit this to the appliance easily yourself.
For a description of fixing the head holder to the appliance please refer to the drawing which is enclosed in the packing for the head holder.

1.5 Technical specifications

1.5.1 Specifications Phyaction 190

Duty-cycle:	continuous 1:1
	pulsating 1:2, 1:4, 1:8, 1:16
Treatment clock:	adjustable 0-30 minutes, linked to contact control
Intensity:	0 - 1.5 W/cm^2 at 3.3 MHz continuous
	0 - 2 W/cm^2 at 0.8 MHz continuous
	0 - 3 W/cm^2 at 0.8 and 3.3 MHz pulsating
Read-out:	intensity in W/cm^2
	effective output power in W
Pulse repetition frequency:	100 Hz
Memory:	20 memory places available
Combination therapy:	possibility to connect an electrotherapy appliance

1.5.2 Specifications treatment heads

ERA:	1 cm^2 (model 91) and 4 cm^2 (model 92)
Frequencies:	0.8 MHz and 3.3 MHz
BNR:	< 5 at 0.8 MHz
	< 4 at 3.3 MHz

The treatment heads are watertight according to IEC 601-2-5.

1.5.3 Technical information

Dimensions:	38 x 22 x 15 cm
Weight:	5 kg
Insulation class:	I, type BF
Voltage:	110, 220, 230 or 240 Volt, 50-60 Hz
Input current:	maximum 300 mA_{eff} at 220 V and 600 mA_{eff} at 110 V

1.5.4 Replaceable parts
Fuses in the mains entrance.

CHAPTER 2 THEORY OF OPERATION

2.1 Introduction

In this chapter the electronics of the Phyaction 190 will be explained. A description on the level of functional block diagrams will be used. The electronics will be described in more depth when safety aspects are concerned.
The Phyaction 190 is a device for ultrasound therapy. The user -the physical therapist- can set a number of parameters. The parameters are converted in electric signals for the ultrasound unit by a microcontroller. Also the microcontroller continuously checks whether the ultrasound unit produces the proper amount of ultrasound energy.

2.2 General block diagram

The block diagram of the Phyaction 190 is shown in figure 2.1. The microcontroller core, shown in the middle of the diagram, controls the complete apparatus. The user can set most of the parameters with the keyboard, which is shown at the left of the microcontroller. The intensity of the ultrasound can be set with the intensity knob, drawn to the right of the microcontroller. The actual parameters and the amount of ultrasound energy actually being administered to the patient is shown on the graphical display.

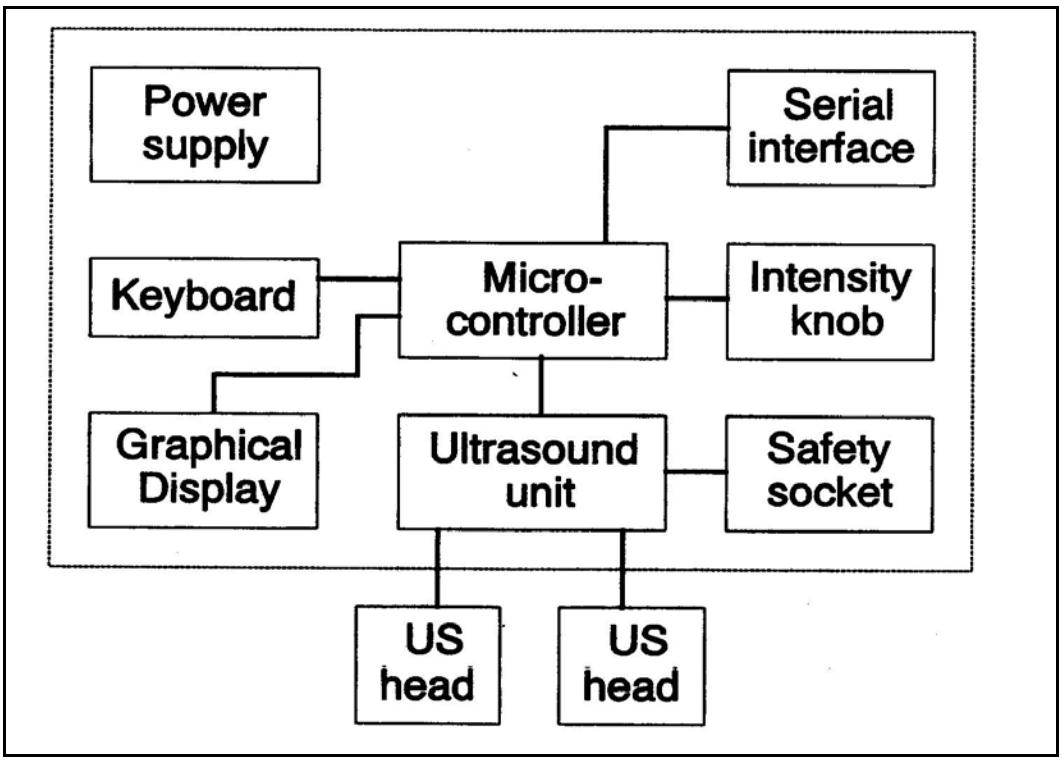


Figure 2.1, Functional block diagram of the Phyaction 190

The ultrasound unit, drawn under the microcontroller, generates the electrical signal the US-head converts into ultrasonic vibrations. The 4 mm banana safety socket, drawn close to the ultrasound unit, allows the user to apply combination therapy when an electrotherapy device is connected to this bus.

2.2.1 The microcontroller core

The microcontroller used in the Phyaction 190 is an 80C552. The 80C552 is an MCS-51 type controller (8051) with a number of extra features on the chip:

- 256 byte RAM memory (instead of 128 byte in 8051)
- 3 timer / counters (2 in 8051)
- eight channel 10-bit AD converter (N.A. in 8051)

- 5 eight-bit wide I/O ports (4 in 8051)
- 2 eight-bit pulse width modulators (PWM) (N.A. in 8051)
- I^2C bus for serial data transfer (N.A. in 8051)
- UART for serial data transfer (e.g. RS232)
- watchdog timer (N.A. in 8051)

Next to the microcontroller the following parts are present in the core:
- 8 kByte (expandable to 32 kByte) RAM data memory
- 1 Mbit EPROM program and constant data memory
- 256 byte I^2C E^2PROM non-volatile data memory
- 2 HCMOS IC's for decoding and buffering purposes

2.2.2 Keyboard
The keyboard is a matrix of 10 push buttons connected to the microcontroller via an I^2C I/O expander. The microcontroller software defines the function of each key. The user can use the keyboard to set and change a number of parameters (such as the active treatment head, treatment frequency, duty-cycle, treatment time etc.)

2.2.3 Graphical user interface
A 240 x 64 dots LCD display with CFT backlight is used as graphical user interface. On it the user can see the current function of the function keys, the parameters, the remaining treatment time, the selected intensity and the resulting effective energy being radiated by the treatment head. Further the contact ration between treatment head and patient is shown on the display.

2.2.4 Safety socket
The 4 mm banana safety socket is directly connected to the tin can of the ultrasound unit. This Tin can is the 'ground' of the circuitry, which is also connected to the metal front of the treatment heads. This socket can be used for combination therapy with external electrotherapy appliances.

2.2.5 Serial interface
No serial interface is available to the user. Only with an opened apparatus the serial interface can be used for testing purposes. This interface is a 5V-level RS232 interface (a direct connection to the UART of the microcontroller). The interface is for extended service features (used by manufacturer only).

2.2.6 Power supply
The power supply is a conventional one with a mains transformer suited for medical purposes. It is equipped with the required primary and secondary fuses, two bridge rectifiers and two capacitors. The unstabilised +29 V is used to feed the ultrasound unit. In the ultrasound unit the +29 V is further used to create a controlled ultrasound supply and two stabilized supplies of +24 V and +15 V.
The unstabilised +9 V is used to create a microcontroller controlled switchable +8 V for the LCD contrast and its backlight and to create a +5 V for the logic components. A reset signal for the microcontroller and LCD is generated when the +5 V comes in or when it drops below a certain voltage.

2.3 Ultrasound unit
The functional block diagram of the ultrasound unit is shown in figure 2.2. Since the signals to generate ultrasound are made using a square wave of about 1 MHz or 3 MHz, it is necessary to encapsulate the complete ultrasound unit, including the ultrasound crystal, in a metal case (a Faraday cage). In figure 2.2 the metal case is indicated by the dashed line. The electronics is put into a 'tin can'. It will be clear that the ultrasound treatment head cannot be put in the tin can, so to maintain the shielding the crystal is put in an aluminium cup, while the signal wire from the electronics to the crystal is a double braided coaxial cable (double shielded).

The keyboard is used to set the various parameters, such as duty-cycle, treatment time and frequency (1 MHz or 3 MHz). The microcontroller computes the operating frequency of the crystal, using a couple of treatment head parameters fed to the apparatus at installation time. The same head parameters are also used to calculate the administered amount of ultrasound energy and the rate of contact between treatment surface and patient. Keeping track of the treatment time is also done by the microcontroller.

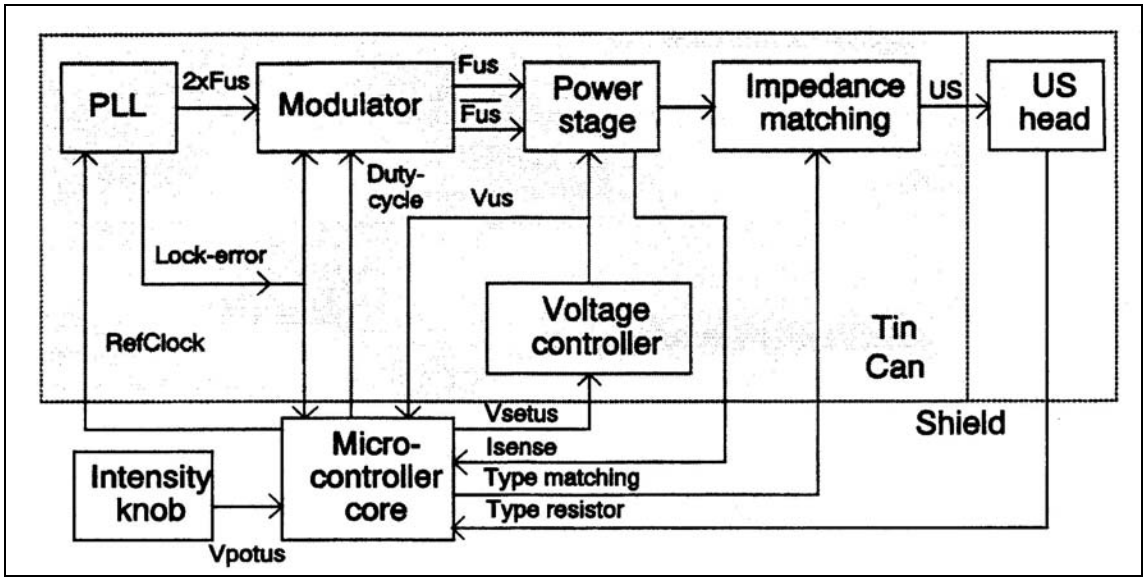


Figure 2.2, Functional block diagram of the ultrasound unit

Countdown of the treatment time is stopped when the microcontroller notes that there is no or not enough contact between treatment head and patient. The intensity of the ultrasound can be adjusted by the user using the intensity knob. Depending on the voltage *Vpotus* the microcontroller computes and sets the required voltage *Vus* with the controlling voltage *VSetUs* in order to generate the desired amount of ultrasound.

2.3.1 PLL

The required ultrasound frequency *Fus* of 0.8 MHz or 3.3 MHz cannot be generated by the microcontroller itself. For this reason a phase locked loop (PLL) is used to transform a low-frequent signal *RefClock*, that the microcontroller can generate, up to the desired steering frequency of *2XFus*. The modulator divides this double frequency and mixes it with the desired duty-cycle.
The frequency generated by the microcontroller is always around 400 Hz. In order to obtain ultrasonic frequencies of both 0.8 MHz and 3.3 MHz a programmable divider is used in the PLL. Whenever the PLL is out of lock (e.g. when changing the frequency for contact control calculations) the *Lock-error* signal is used to stop the modulator in order to prevent erroneous frequencies being produced by the treatment head.

2.3.2 Modulator

To obtain a symmetrical steering signal for the power stage the modulator switches its outputs with half the input frequency. Also the modulator mixes the *duty-cycle* signal synchronously with the ultrasound frequency to prevent spikes. An amplitude modulation with 100% modulation depth (the signal being switched on and off) is the result of this mixing. With the *Lock-error* signal the modulator can be forced to shutdown. This action can be taken by the PLL when it is out of lock or by the microcontroller. The *Lock-error* line can be used as an input as well as an output by the microcontroller.

2.3.3 Voltage controller

A pulse controlled downward converter voltage controller is used to convert the unstabilized +29V to the desired ultrasound voltage. The voltage controller is made in such a way that its output voltage is linear proportional to its input voltage *VSetUs*. Thus the microcontroller can adjust the ultrasonic power by setting *VSetUs* proportional to the square root of the desired output power. The microcontroller constantly monitors the output voltage of the voltage controller. If the output voltage is too high (because of a hardware failure), the microcontroller will shut down the ultrasound unit and give an error message.

2.3.4 Power stage

The power stage is a switched balance class-D end stage. The generated output power is controlled by *Vus*, generated by the voltage controller. The above mentioned modulator controls whether the power stage is active. Power MOSFETs are used as switching elements. The MOSFETs are driven by buffers that also take care of a small delay in driving the MOSFETs, to prevent them of being active simultaneously. If either one of the MOSFETs has become defective, both of them should be replaced. In that case the adjustment of the delays in the FET-drivers should be carried out. This adjustment cannot be executed in the field, it has to be carried out only by Uniphy personnel.

2.3.5 Impedance matching

The ultrasound crystal is mainly a capacitive load. Its impedance differs, among other things, with the size of the crystal and its operating frequency. For this reason the microcontroller can match the impedance by switching one or two inductors and when necessary capacitors in the output stage.

2.3.6 US head

The ultrasound treatment head is of course a very important part of the apparatus. It converts the electric signal into ultrasound using a piezo crystal. This crystal, with a diameter depending on the desired head size, is glued in an aluminium cup that minimizes electromagnetic radiation and enables the crystal to be used on to operating frequencies.
The aluminium cup can also be used as a second electrode if combination therapy is desired. A separate electrotherapy device needs to be connected to the safety socket for combination therapy.
A resistor is in the connector of the treatment head to enable the microcontroller to detect whether a head is connected and to recognize the type of head that is connected.

CHAPTER 3 PERFORMANCE CHECK

3.1 Safety inspection

This inspection is for technical maintenance purposes only. It is recommended that this test is carried out once a year. If the appliance is serviced, the full IEC 601-1 tests have to be carried out. A short description of these tests is in section 3.2.

3.1.1 Visual inspection

Passed, when all applicable items are answered with YES.

	yes	no
Is the user manual there?		
Is the casing of the appliance undamaged?		
Is the label well readable?		
Are the controls, display, lights and connectors all right?		
Are the mains input and the equipotentiality busbar all right?		
Are ultrasound treatment heads, cables and connectors undamaged? (Pay special attention to possible leaks in the treatment heads, such as cracks or loosened seems.)		
Are the labels on the ultrasound treatment heads readable?		

3.1.2 Functional test

Passed, when all applicable items are answered with YES (or not applicable).

		yes	no
Is the automatic selftest executed successfully at power on?			
Is the appliance adjusted to all treatment heads?	1 cm²		
	4 cm²		
Does the ultrasound output correspond with the power displayed on the	1 cm²		
LCD, for both frequencies at maximum intensity?	4 cm²		

3.1.3 Test of the electrical safety according to VDE 0751

Parameter	Measured value	Limit	Remarks
Protective earth resistance	Ω	< 0.2 Ω	
Enclosure leakage current	µA	< 1000 µA	
Patient leakage current	µA	< 5000 µA	

Also register the measured values in the device records and compare them with the values measured in the past to alert for a possible potentially dangerous tendency.

3.2 IEC 601-1 safety tests

For the full description of these tests we refer to the IEC 601-1 (1988) for Class I, Type BF equipment. Here is just a short reminder list of the tests and the test limits.

Measurements	limits
Insulation resistance mains	> 2.0 MΩ
Insulation resistance applied part	> 2.0 MΩ
Protective earth resistance	< 0.2 Ω
Enclosure leakage current normal	< 100 µA
Enclosure leakage current open lead	< 500 µA
Enclosure leakage current open earth	< 500 µA
Enclosure leakage current reverse	< 100 µA
Enclosure leakage current open lead	< 500 µA
Enclosure leakage current open earth	< 500 µA
Earth leakage current normal	< 500 µA
Earth leakage current open lead	< 1000 µA
Earth leakage current reverse	< 500 µA
Earth leakage current open lead	< 1000 µA
Patient leakage current normal	< 100 µA
Patient leakage current open lead	< 500 µA
Patient leakage current open earth	< 500 µA
Patient leakage current reverse	< 100 µA
Patient leakage current open lead	< 500 µA
Patient leakage current open earth	< 500 µA
Mains on applied part normal	< 5000 µA
Mains on applied part reverse	< 5000 µA
Dielectric strength A.P. + CASE to MAINS *	> 1500 V_{rms}
Dielectric strength MAINS + CASE to A.P. *	> 1500 V_{rms}

* These tests need only be executed if repairs have been made in the mains part or in the output circuits.

3.3 Performance check of the ultrasound treatment heads

In the software of the Phyaction 190 a special menu for service purposes only is included. Most of these features can be used for trouble shooting. You can find the description of the other items of the service software in chapter 4 TROUBLE SHOOTING, section 4.3 *Description of the service software*. In this section the software that is made to check the contact detection of the ultrasound heads will be described.

You enter the service menu by holding down the fourth and sixth blue function key while switching on the device. As soon as you hear the buzzer you should release the keys. If you did it right, you will see at the bottom of the start-up screen that the Phyaction 190 is in service mode. You can now enter the service menu by holding down the yellow key for about 3 seconds. For software version 3.01 and up you should press the fourth and sixth blue function key again to get the full service menu. You should be aware that the full service menu is for service personnel only, so never tell a physiotherapist or doctor how to enter this menu, because they might do things that will harm the appliance or the treatment heads. To check the performance of the ultrasound head, select menu item 3 *Check Vusi dry/wet*.

You can connect one or two treatment heads, the appliance will measure both at the same time if two heads are connected. On the LCD you will see an instruction to make the heads dry. Make sure that no water or gel is on the treatment surface of the heads. Then you press the green button (memory), as instructed. The

microcontroller will measure a voltage (Vusi) which is related to the current that is flowing through the treatment head: Vusi dry. After this measurement you will see an instruction on the LCD to put the treatment heads in water. Put the treatment heads in a spacious bowl of water (room temperature) and make sure that the ultrasound waves which are reflected by the bottom or the side of the bowl don't come back to the treatment heads, because that might affect the integrity of the measurement. Then press the green button as instructed. The microcontroller will then measure the same parameter as before: Vusi wet. In the following table are the values for the different frequencies and treatment heads which should be met.

Head type	frequency	Vusi dry / Vusi wet
Small	1 MHz	> 1.5
Small	3 MHz	> 1.3
Large	1 MHz	> 1.5
Large	3 MHz	> 1.3

If the measured values don't meet the specifications, you can first try to remeasure it with the treatment head in a different angle in the bowl of water. If that is giving similar results, then check the numbers on the treatment head label with the numbers in the appliance (see section 1.3.6 *Checking the ultrasound heads* or Appendix 2 TUNING THE ULTRASOUND TREATMENT HEADS). If all of these things are checked and meet the specifications, then the treatment head is probably defective and should be exchanged.

CHAPTER 4 TROUBLE SHOOTING

4.1 Introduction

If a Phyaction 190 is defective, in most cases the unit will detect an error in the automatic self test. A full description of this test will therefore help the service technician in finding the error. In the next paragraph you will find this description. Some errors may only occur during normal operation, so you will also find the tests that are carried out during normal operation in that section. To give the service technician some extra tools for trouble shooting, Uniphy has developed a special service menu with features specially for service operations. This service software is described in section 4.3. Finally in Appendix 3 you will find a list of all possible error messages and possible causes.

4.2 Description of the automatic selftest

This paragraph describes the internal self test of the Phyaction 190, the (critical) error messages and the possible cause of the errors.

The following categories of errors are identified:

- Errors during self test
- Errors during normal use
- Software errors

If simple errors occur that can be corrected by the user an error message appears on the bottom line of the display. These messages show the kind of error and a possible solution. These errors are described in the user manual. Errors that cannot be corrected by the user are displayed as shown in figure 4.1 (where the numbers are randomly chosen).

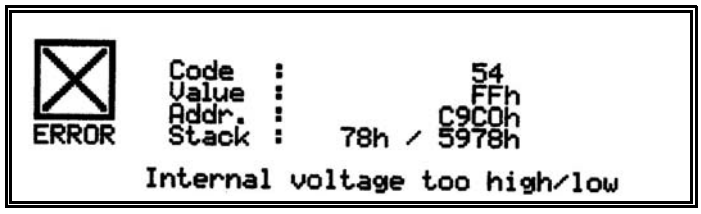


Figure 4.1, Error message

The error codes presented after 'Code:' are described in paragraphs 4.2.3 and 4.2.4. In some cases the hexadecimal number after 'Value' gives additional information about the error. The error address indicates the address of the routine where the error occurred. The hexadecimal values after 'Stack:' represent the position of the stack pointer and the contents of the stack, showing the value of the program counter when the error routine was called.

If the error routine detects that the LCD display is not functioning properly, or if the display is not yet initialized, the buzzer will be activated a number of times. The number of beeps indicate the type of error (see also paragraphs 4.2.3 and 4.2.4)

4.2.4 Error shutdown procedure

If the processor detects an error that cannot be corrected by the user, the complete ultrasound unit is put in a safe condition and the processor will enter an infinite loop in which normal operation is not possible. If an error is encountered that the user can correct, it will depend on the kind of error whether the ultrasound unit is switched off or continues working.

The following shutdown procedure takes place:

- The red ERROR-LED is switched on
- The Fan starts working
- The buzzer will sound for approximately half a second
- The duty-cycle is set to 0
- The ultrasound voltage is set to its minimum value

- The ERROR-us line is activated, inhibiting the 1MHz or 3MHz to enter the power stage of the ultrasound unit
- If the LCD cannot be accessed a number of beeps will be generated
- If the RS-232 port can be used the error number is sent over the RS-232 channel
- The error information is sent to the LCD (when it can be accessed)
- A short description of the error is displayed (e.g. I²C error)
- All interrupts are disabled
- The processor enters an infinite loop

4.2.5 Description of the self test

Since the microcontroller performs the self test, it will start by testing itself and its program and data memory. If this test shows no errors, the microcontroller will check its analog and digital I/O ports. Next the ultrasound unit is tested. And finally a number of small tests is performed. The latter tests are done both during self test and during normal operation.

If the unit does not complete its self test, when no errors are displayed and the buzzer does not sound the following should be checked:
- All supplies, including mains (is the mains plug connected properly and are the fuses not blown?)
- Is the internal wiring properly connected?
- Is the microcontroller operating properly?
- Is the program EPROM with a proper program installed?
- Are data-, address- and control lines of the processor in order?

It will be clear that the user can check the mains and fuses. All other possible error causes have to be tested be a service technician.

The next paragraphs discuss the internal tests performed in the automatic self test. The order in which the tests are discussed is not necessarily the same as the order in which they are performed.

Microcontroller core test

The following tests will be performed to check proper functioning of the microcontroller and its required hardware (program and data memory).
1) The ALU and a number of instructions are verified. When an error is met **ERROR 00** is generated and 6 beeps will sound.
2) The internal memory (the registers of the microcontroller) is checked. If an error is met in the internal memory **ERROR 01** is generated and 6 beeps will sound. **Value** indicates in which register the error is encountered.
3) The external RAM is checked. If an error is met in the external RAM or if the RAM is not present, **ERROR 02** is generated and 6 beeps will sound.
4) The first 32 kByte of program memory is tested against a known checksum. If the calculated checksum differs from the expected checksum **ERROR 04** is generated and 6 beeps will sound.

After the internal core test, the microcontroller will test the peripherals:
1) The bank-switching hardware is tested. If bank 0 cannot be found, **ERROR 03** will be generated and 6 beeps will sound.
2) Timer 0 and timer 1 are initialized and tested. If timer 0 works improperly either **ERROR 07** or **ERROR 09** with **Value 00** will be generated (which error is actually generated depends on the place in the program where the error is occured). If timer 1 does not function properly **ERROR 09** with **Value 01** will be generated. Together with ERROR 07 or ERROR 09 six beeps will sound.
3) The Analog to Digital converter hardware is checked. This test is done in two steps with different error codes if it fails.
   a) Testing of the ADC sequence and interrupt handling. In case of an **ERROR 08** is generated and 6 beeps will sound.
   b) Verifying the converted values. The reference voltage Vref of the reset IC is an accurate reference for checking the ADC. If the measured Vref is above **2.63V** or below **2.39V ERROR 56** is generated. This error is caused by not proper functioning of either the reset circuit or the ADC.
4) The serial (RS-232) interface is initialized and tested. **ERROR 27** is generated if a time out occurs.
5) Timer 2 is initialized and tested. **ERROR 09** with **Value 02** is generated on a time out.

6) The Liquid Crystal Display is initialized and tested. **ERROR 21** is generated on a time out. Since this error message most probably cannot be displayed, 1 longer beep and three short beeps are generated.
7) The I²C bus is initialized and tested. **ERROR 11** is generated on a time out. **Value** will show the address of the device that has caused a time out.
8) The second part of the program EPROM is checked (Checksum). If an invalid checksum is found **ERROR 05** is generated and 6 beeps will sound.
9) The keyboard is checked. If a key is pressed during self test **ERROR 41** is generated. The key that is pressed is shown in **Value**.
10) The I²C E²PROM (the non-volatile memory) is checked. If it contains an incorrect checksum **ERROR 31** is generated with the (new) checksum as **Value**. If the E²PROM has an invalid signature, **ERROR 32** is generated.
11) A reference voltage of 2.5V is measured. If the measured value is above **2.63V** (**086h**) or below **2.39V** (**079h**) **ERROR 56** is generated. The measured 8-bit AD value of Vref is shown as **Value**. With this reference voltage both the reset IC and the ADC are checked.
12) The Intensity potentiometer is checked. The reference voltage on the potentiometer must be between **3.75V** (**0BFh**) and **4.40V** (**0E0h**), otherwise **ERROR 54** is generated. Further, the voltage of the potentiometer must correlate with the zero-switch of the potentiometer. If the switch indicates that the potentiometer is in its zero position, the measured voltage must not exceed **0.19V** (**00Ah**), or else **ERROR 55** is generated.

Test of the ultrasound unit

Checking the treatment head types

During self test the microcontroller checks the voltages from the treatment head resistors. If an unknown head is found, i.e. if a voltage is not between **0.88V** (**02Ch**) and **1.48V** (**04Bh**), between **2.20V** (**070h**) and **2.80V** (**08Eh**) or above **4.90V** (**0F9h**), **ERROR 58** is generated. **Value 10** indicates an invalid voltage on the left output, while **Value 01** indicates this for the right output. During normal operation an unknown head type does not generate a critical failure. During start-up though, it could indicate a hardware error in the head detection hardware.

Checking the ultrasound voltage

1) After power on of the unit the PWM is in its minimum position ($^0/_{255}$). Any voltage still present in the ultrasound unit (e.g. caused by a rapid off and on switching) is discharged by switching the ultrasound unit on for a short moment. Next Vsense is measured and should be below **3.0V**. If Vsense is above this value, **ERROR 51** is generated.
2) The PWM is set to a value close to maximum ($^{235}/_{255}$). The ultrasound voltage should reach at least **23.5V** within appr. 40 msec, otherwise **ERROR 52** is generated.
   The two values that are just measured (at PWM 0 and PWM 235) are used to determine the behaviour of the SMPS power supply.
3) The duty-cycle is set to zero and Isns is measured. The voltage representing Isns should be below **0.05V**, otherwise **ERROR 59** will be generated.
4) The PWM is set to its minimum value ($^0/_{255}$) and the ultrasound unit is activated. Now the ultrasound voltage should reach a value of less than **17.0V** within appr. 1 second. Otherwise **ERROR 53** will be generated.
5) During self test and also during normal use the PLL is checked on not going out of lock. If the PLL does go out of lock, **ERROR 60** is generated.

Other tests during normal use

The following tests are performed on a regular basis during normal use:

1) The internal temperature is checked. If it goes above appr. 45°C, the fan is switched on. Should the inner temperature rise above appr. 65°C, a critical error: **ERROR 70** is generated.
2) The reference voltage over the intensity potentiometer is tested constantly. If this voltage is outside its limits (from **3.75V** (**0BFh**) to **4.40V** (**0E0h**)), a critical error is generated (**ERROR 54**)
3) The PLL is tested during body contact measurement. If the PLL goes out of lock **ERROR 60** is generated. This error can be caused either by the PLL or by a malfunction in timer 2.
4) The ultrasound voltage is constantly checked. If this voltage is higher than **28.5V**, **ERROR 57** is generated.
5) Every time an I²C device is accessed, the I²C protocol is checked on a time out. If a device does not respond within a certain time limit, **ERROR 11** is generated, with **Value** the address of the not responding device.
6) Every time the LCD display is accessed it has to respond within a certain time. Otherwise **ERROR 21** is

generated.

7) Every time the software waits on a signal from timer 0, timer 0 is also checked. If a time out is given, **ERROR 07** is generated.
8) Once the microcontroller has entered its normal program loop, it should never leave this loop. If the microcontroller leaves the normal program loop **ERROR 90** is generated.

4.3 Description of the service software

In the software of the Phyaction 190 a special menu is included for service purposes only. Most of these features can be used for trouble shooting. You enter the service menu by holding down the fourth and sixth blue function key while switching on the device. As soon as you hear the buzzer you should release the keys. If you did it right, you will see at the bottom of the start-up screen that the Phyaction 190 is in service mode. You can now enter the service menu by holding down the yellow key for about 3 seconds. For software version 3.01 and up you should press the fourth and sixth blue function key again to get the full service menu. You should be aware that the full service menu is for service personnel only, so never tell a physiotherapist or doctor how to enter this menu, because they might do things that will harm the appliance or the treatment heads.

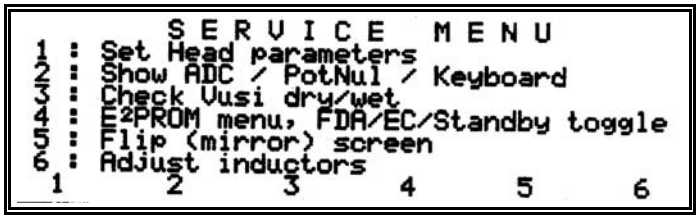

SERVICE MENU
1 : Set Head parameters
2 : Show ADC / PotNul / Keyboard
3 : Check Vusi dry/wet
4 : E²PROM menu, FDA/EC/Standby toggle
5 : Flip (mirror) screen
6 : Adjust inductors
1 2 3 4 5 6

Figure 4.2, Full service menu

If you press the yellow button in the main service menu, you return to the normal therapy screen. To get the appliance out of the service mode you have to turn off the device.

In the following sections all menu items of the service menu will be described.

4.3.1 Set head parameters

Item 1 of the service menu, *Set head parameters*, is described in Appendix 2 TUNING THE APPLIANCE TO AN ULTRASOUND TREATMENT HEAD.

4.3.2 Show ADC / Potnul / Keyboard

With item 2 of the service menu, *Show ADC / Potnul / Keyboard*, you can read back the voltages at the Analog to Digital Convertor inputs. Also the measured internal temperature is displayed. At the right of the screen you will see a picture of the keyboard of the Phyaction 190. Pressing one of the keys should light up the corresponding key on the picture. Pressing the up key will start the fan, pressing the down key will stop the fan. To exit this screen and return to the main service menu, you hold the yellow key for 5 seconds.

4.3.3 Check Vusi dry/wet

Item 3 of the service menu, *Check Vusi dry/wet*, is described in section 3.3 *Performance check of the ultrasound treatment heads*.

4.3.4 E²PROM menu, FDA/EC/Standby toggle

If you choose item 4 of the service menu, *E²PROM menu, FDA/EC/Standby toggle*, you will get another menu, the E^{2}PROM MENU, see figure 4.3.

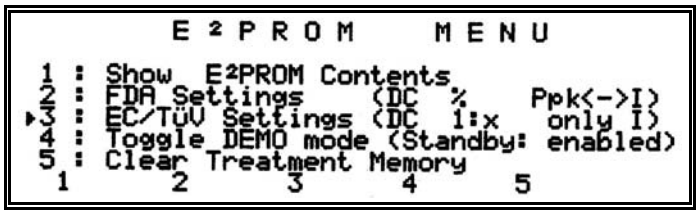

E ² P R O M M E N U
1 : Show E²PROM Contents
2 : FDA Settings (DC % Ppk<->I)
3 : EC/TüV Settings (DC 1:x only I)
4 : Toggle DEMO mode (Standby: enabled)
5 : Clear Treatment Memory
1 2 3 4 5

Figure 4.3, E²PROM menu

In this menu you have several choices to display and alter the contents of the I²C E²PROM.

1. Show E²PROM Contents

If you choose this item the contents of the memory is displayed on the LCD. It starts with the head parameters with the measured Vusi, then the contrast is shown and the default setting (TÜV / FDA). On the last line of this screen treatment memory use is shown. If one of the black keys ⮝ or ⮟ is pressed, you can scroll through a hexadecimal display of the memory contents.

2. FDA Settings

With the blue function key F2 you can set the appliance in the FDA (American) settings. An arrow head will appear before the FDA settings line. In FDA mode the duty cycle will be displayed in a percentage instead of a ratio (example 25% instead of 1:4) and you can toggle between intensity and peak power setting.

3. EU/TÜV Settings

With the blue function key F3 you can set the appliance in the European or TÜV settings. These settings are also the default settings when an E²PROM is initialised. An arrow head will appear before the EU/TÜV settings line.

4. Toggle DEMO mode

If the appliance is not generating ultrasound, it will show a screen saver after 5 minutes of non activity. After approximately 5 minutes the screen saver disappears and the LCD backlight is switched off. To prevent the appliance to go in screen saver mode (e.g. for demonstrations) you can press the blue function key F4. An arrow head will appear before this line to indicate that the screen saver is disabled. Pressing F4 again will enable the screen saver.

5. Clear Treatment memory

The treatment memory can be cleared one location at a time in the memory menu. However if you want to clear the complete treatment memory (e.g. after filling it with test values) you can use this function.

4.3.5 Flip (mirror) screen

When servicing the appliance it is very easy to put it on its rear side. In this position you can unscrew the bottom plate and open it towards you. In this position it is possible to turn on the appliance while it is opened, so you can measure signals for trouble shooting purposes. If you still want to be able to see the information on the LCD, it is very convenient to put a mirror behind the appliance. Flipping the screen with this menu item enables you to read the information on the LCD, even though it is in a mirror.

4.4 Error messages

Every error is internally represented by a number. If an error is encountered, this number is shown on the LCD display (if possible) and sent to the serial port (if possible). Should the microcontroller not be able to show the number on the display, an acoustic signal is given. The list is in Appendix 3.

CHAPTER 5 EXCHANGING BOARDS AND MODULES

5.1 Introduction

The most frequent service operations will be the exchanging of boards or modules, because it would be too time consuming and costly to do component level service in the field. When exchanging boards or modules there are a few things that should be noticed. These attention points will be described in this chapter.

If you want to exchange a module or a board you will have to open the appliance. It is probably easy to place the appliance on its rear side, with the bottom side towards you. You can unscrew the 5 screws of the bottom plate and tilt it towards you. If you want to test and make measurements you can leave the cables and connectors where they are, but if you want to exchange a board or module it is better to disconnect the cables and seperate the bottom plate from the rest of the appliance.

If you have exchanged a board or module, always test the appliance. This functional test starts with switching the device on and checking the 4 LEDs, the fan and the LCD. If no error messages appear, check the memory (can you store a setting and retrieve it). Finally check the contact detection of the ultrasound heads. After this you should do a safety test (short description in section 3.2).

In general it should be said that you should take the necessary precautions to prevent electrostatic discharges occur on the delicate electronic circuits of the unit. These precautions implicate that you should ground the unit, use a grounded desk overlay, ground the tools such as solder irons and you should be connected to ground by the usual wrist or ankle strap.

5.2 Exchanging the software or the main board (PCB 192X)

If you want to exchange the software or the main board of the appliance, you first open the appliance as described in section 5.1 *Introduction*. You disconnect the cable from the transformer to the main board and the cable of the fan. Then you remove the two screws from the main board, which are located at the back of the appliance (between the ultrasound module and the back side). You disconnect the cable from the main board to the keyboard and the cable of the backlight of the LCD. Now you can shift out the board and exchange the EPROM. If you want you can disconnect the other 4 cables, but that is not really necessary. If you want to exchange the main board you will have to disconnect the cables from console and from the LCD backlight, take out the board and disconnect the remaining cables.

If you have exchanged the software or the main board, shift back the PCB on its place and connect all cables. Also connect the transformer cable. Leave the appliance on its rear side and switch it on. If any error message appears on the LCD, switch the appliance off and try to repair the cause of the error. After you have succeeded, you remove the external mains cable and fix the main board with the two screws. Then check whether all cables are connected (fan !!) and close the case. After you have screwed in the 5 screws on the bottom plate, you should do a short functional test and a safety test (short description in section 3.2).

5.3 Exchanging the ultrasound module

To remove the ultrasound module, you first remove the bottom plate as described in section 5.1 *Introduction*. Make sure there are no treatment heads connected to the device. The easiest way to place the appliance is with the front side down. Put it on a soft underground to make sure you don't damage the front side. Disconnect the internal cable from the safety socket and unscrew the safety socket. Remove the screw to the tab at R82/C82, then unscrew the three other screws to release the ultrasound module. You can take the module out of the appliance case, remove the screws from the D-subminiature connector at the back of the module and disconnect the cable.

If you install a new module there are a few things that you have to pay attention to. You start with connecting the cable to the module and fixing it with two screws. There are two O-rings between the front panel and the LEMO chassis parts (the sockets for the ultrasound output) to prevent any liquid from entering the appliance at that place. Make sure the O-rings are undamaged and are positioned in the chambers around the holes for the connectors. If you place the module you should make sure the LEDs are positioned in the LED-lenses. Before you fix the module with the screws you should lift the appliance to make sure the O-rings are still on their place.

The three screws with the mounting material can now be placed. These screws are thread-forming screws. The best way to screw them in is as follows. You put the screw in the hole and first turn it anti-clockwise with a screwdriver. If you feel that the screw is falling into the thread, you screw it in (clockwise). In this way you prevent that a second thread is formed. This second thread wouldn't be very strong and there is even a possibility the screw won't hold at all. This would mean you would have to exchange the front panel, which is at lot of work and a lot of money. Do not forget to fix the tab at R82/C82, ESD performance would be severely impaired. Finally you can put in the safety socket, fix it and connect the cable.

After this you install the bottom plate and do a functional test and a safety test.

5.4 Exchanging the LCD

If you have to exchange the LCD, you first have to remove the main PCB as decribed in section 5.2 *Exchanging the software or the main board (PCB 192X)*. Then you remove the flexcable on the keyboard PCB. After that you can unscrew the four screws in the corners of the LCD module. Now you can take the LCD module out of the appliance.

If you put in a new LCD module, make sure the LCD glass and the inside of the glass that is glued in the front panel are clean. You can put in the new module and fix it with the four screws. These screws are thread-forming screws. The best way to screw them in is as follows. You put the screw in the hole and first turn it anti-clockwise with a screwdriver. If you feel the screw is falling into the thread, you screw it in (clockwise). In this way you prevent that a second thread is formed. This second thread wouldn't be very strong and there is even a possibility the screw won't hold at all. This would mean you would have to exchange the front panel, which is at lot of work and a lot of money. Finally connect the cable on the keyboard panel and re-install the main board.

After this you install the bottom plate and do a functional test and a safety test.

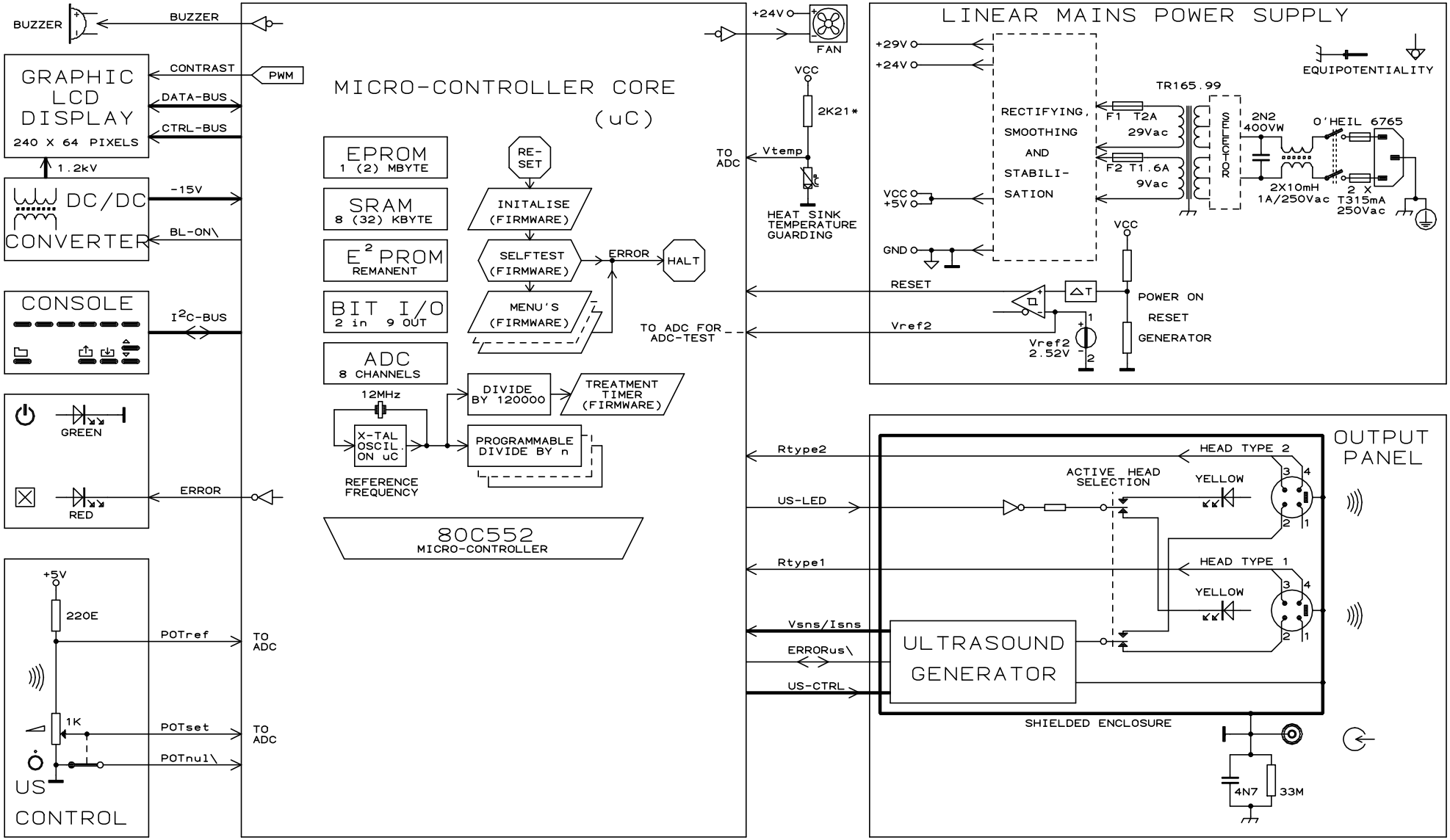
5.5 Exchanging the keyboard PCB (194X)

If you want to exchange the keyboard PCB you will have to remove the bottom plate as described in section 5.1 *Introduction*. Remove the flexcable from the LCD and the cable that is coming from the main board. Now you can remove the five screws and exchange the board.

Between the keyboard PCB and the key knobs is a silicon foil, to prevent any water to reach the electronic circuits or the mains transformer. If there are any holes in the foil, you should exchange that as well.

You can fix the new keyboard PCB with the five screws. These screws are thread-forming screws. The best way to screw them in is as follows. You put the screw in the hole and first turn it anti-clockwise with a screwdriver. If you feel that the screw is falling into the thread, you screw it in (clockwise). In this way you prevent that a second thread is formed. This second thread wouldn't be very strong and there is even a possibility that the screw won't hold at all. This would mean you would have to exchange the front panel, which is at lot of work and a lot of money. Finally you connect the two cables and install the bottom plate and do a functional test and a safety test.

If you switch on the appliance with a new keyboard it may take some time before you get information on the screen. This is because the E²PROM memory on the keyboard has to be initialised. This is also the reason why you will get an error message (Error 32, E²PROM completely blank). Wait for the error message and switch the appliance off and on again. Because the memory is on this PCB, you have to realise the patient memory and all data of the treatment heads are erased. This means you have to reinstall the treatment heads (see Appendix 2).



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Approval:		
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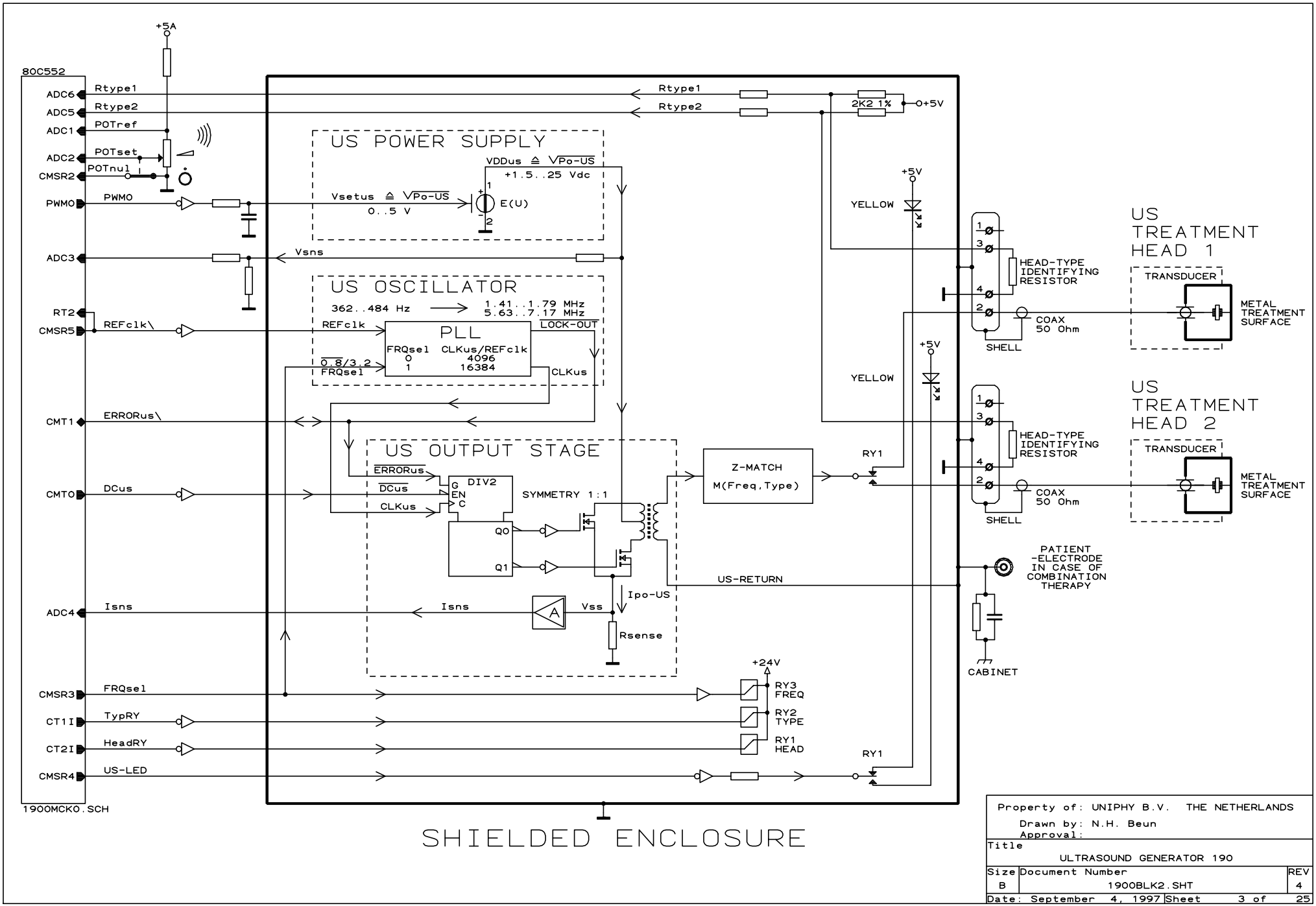
Size: B	Document Number: 1900BLK0.SHT	REV: 4
Date: September 4, 1997	Sheet 2 of 25	



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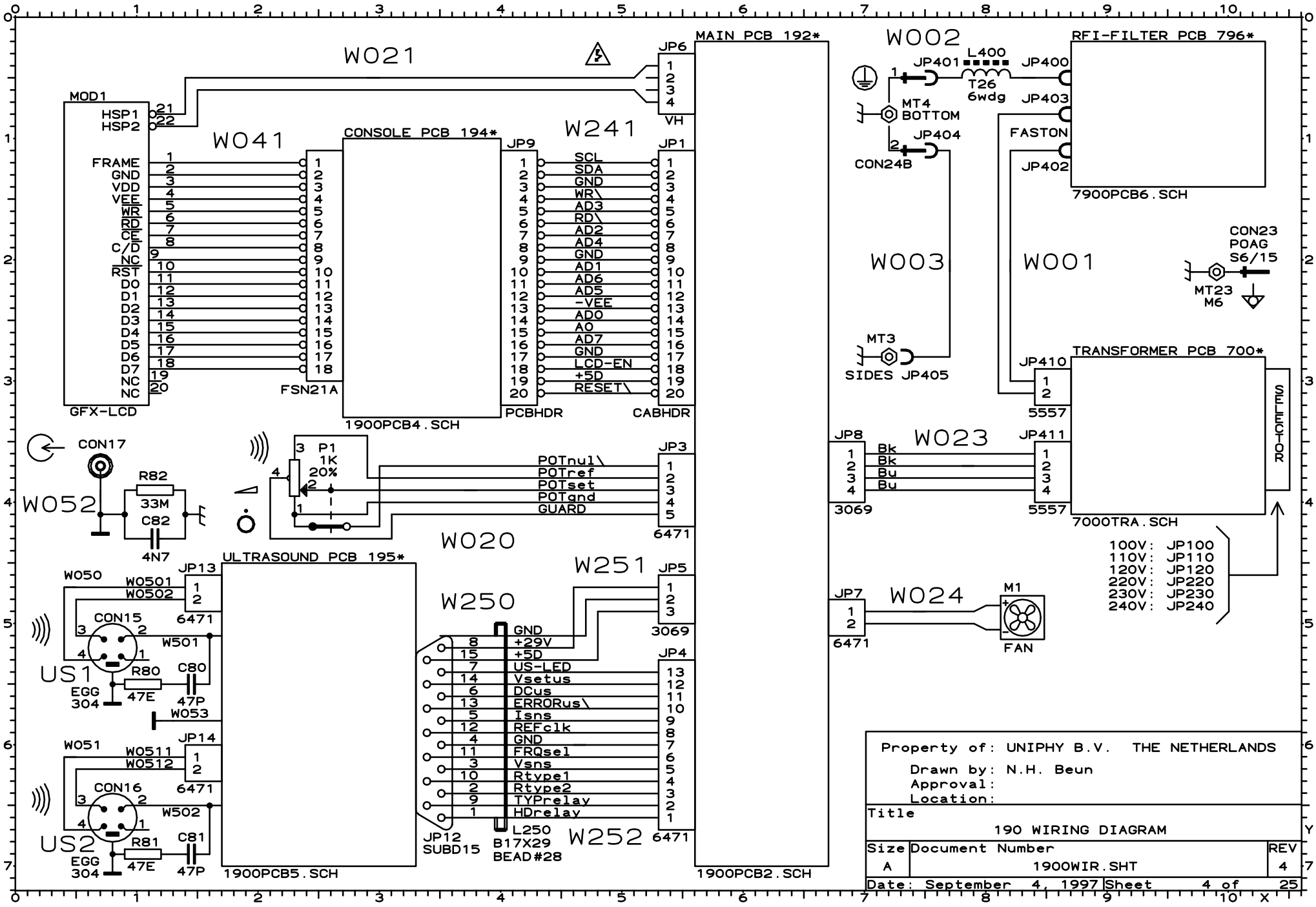
Sheet	3 of 25


MOD1
GFX-LCD
FSN21A
CONSOLE PCB 194*
1900PCB4.SCH
PCBHDR
CABHDR
MAIN PCB 192*
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W021
W041
W241
W002
W003
W001
W023
W024
W020
W250
W251
W252
W052
W050
W051
W053
RFI-FILTER PCB 796*
7900PCB6.SCH
TRANSFORMER PCB 700*
7000TRA.SCH
SWITCH
CON23
POAG
S6/15
MT23
M6
MT4
BOTTOM
CON24B
MT3
SIDES JP405
JP401
JP400
JP403
JP402
JP404
L400
T26
6wdg
FASTON
JP410
JP411
5557
3069
6471
3069
JP8
JP7
M1
FAN
100V: JP100
110V: JP110
120V: JP120
220V: JP220
230V: JP230
240V: JP240
CON17
R82
33M
C82
4N7
P1
1K
20%
POTnul\
POTref
POTset
POTgnd
GUARD
ULTRASOUND PCB 195*
1900PCB5.SCH
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JP14
JP12
SUBD15
CON15
CON16
US1
US2
EGG
304
R80
47E
C80
47P
R81
C81
W501
W502
W0501
W0502
W0511
W0512
GND
+29V
+5D
US-LED
Vsetus
DCus
ERRORus\
Isns
REFclk
FRQsel
Vsns
Rtype1
Rtype2
TYPrelay
HDrelay
L250
B17X29
BEAD#28
SCL
SDA
WR\
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AD2
AD4
AD1
AD6
AD5
-VEE
AD0
A0
AD7
LCD-EN
+5D
RESET\
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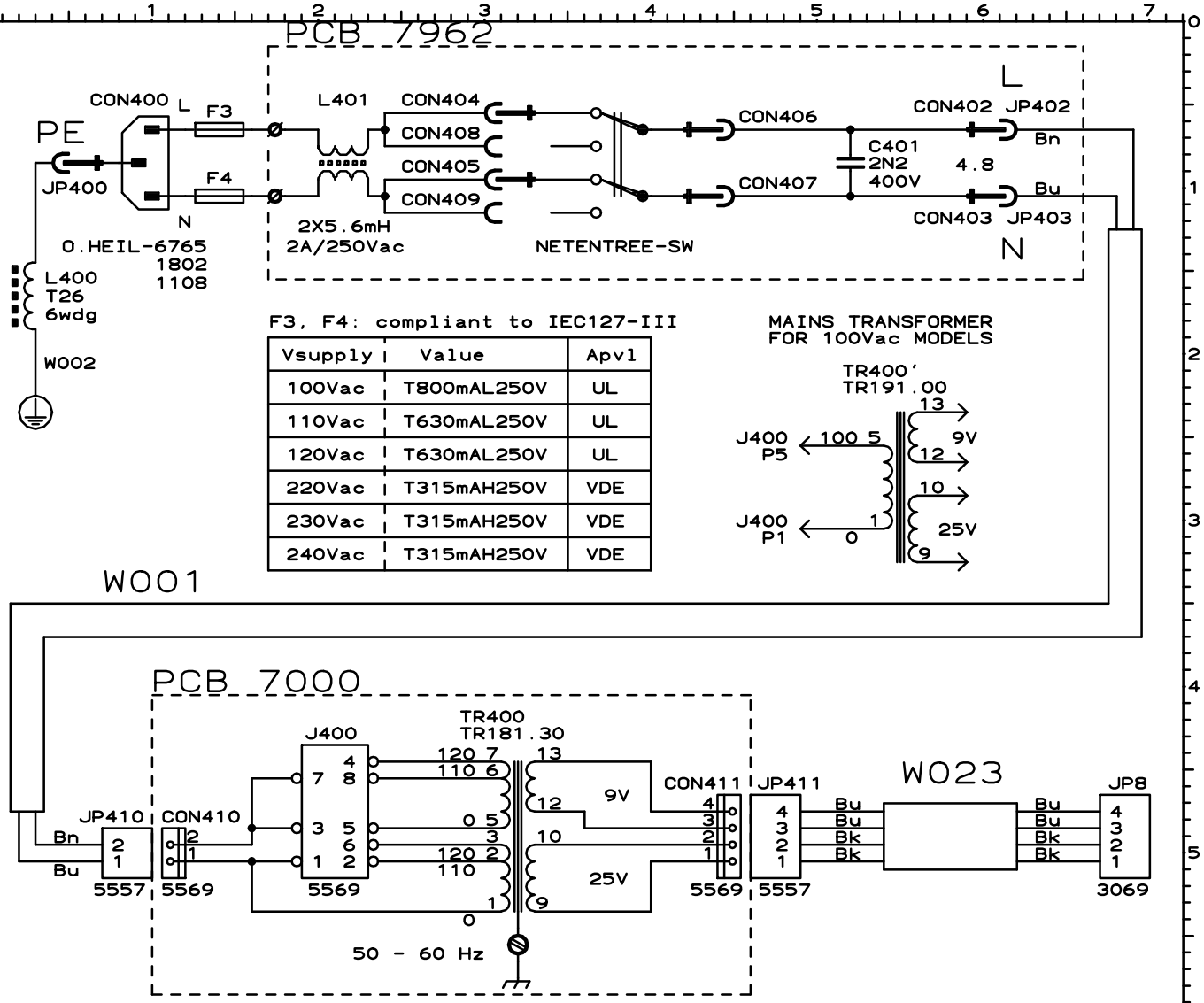
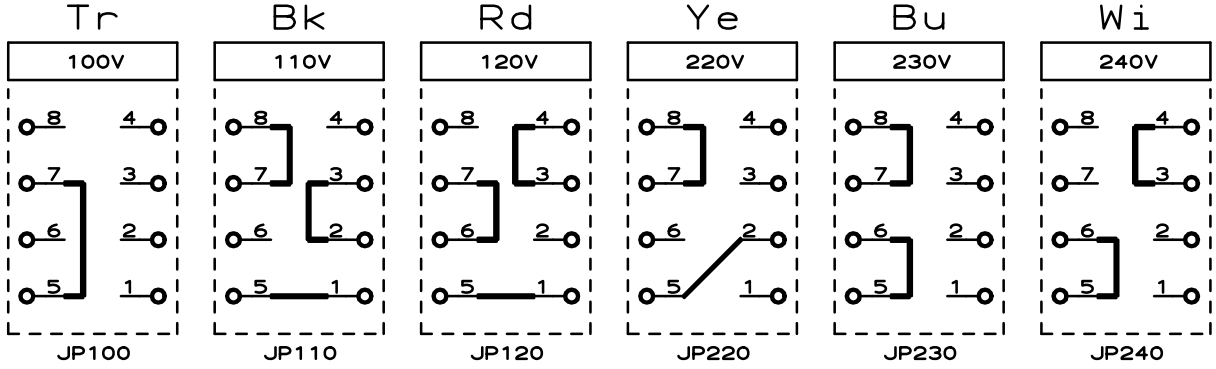


Vsupply	Value	Apvl
100Vac	T800mAL250V	UL
110Vac	T630mAL250V	UL
120Vac	T630mAL250V	UL
220Vac	T315mAH250V	VDE
230Vac	T315mAH250V	VDE
240Vac	T315mAH250V	VDE

SELECTOR WIRING DEPENDENT ON RATED MAINS VOLTAGE

SELECTORS CAN BE IDENTIFIED BY THE COLOR OF THE INSULATION SLEEVE



FOR 100Vac MODELS J400 AND JP100
CAN BE REPLACED BY A SINGLE WIRE

LEGEND FOR COLORS:	
Bk - BLACK	Rd - RED
Bn - BROWN	Wi - WHITE
Bu - BLUE	Ye - YELLOW
Tr - TRANSPARANT	

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Title
190 MAINS PART

Size	Document Number	REV
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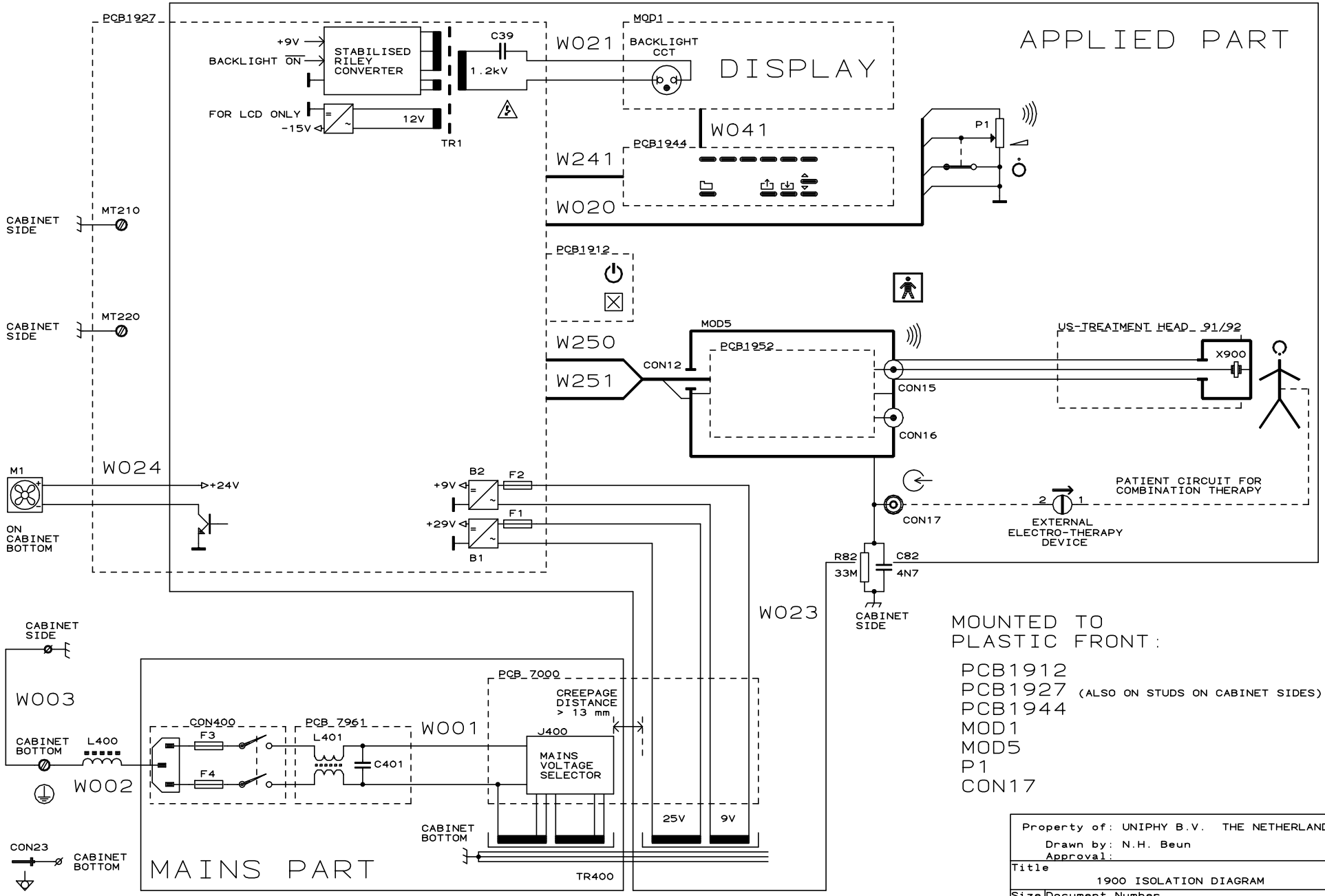

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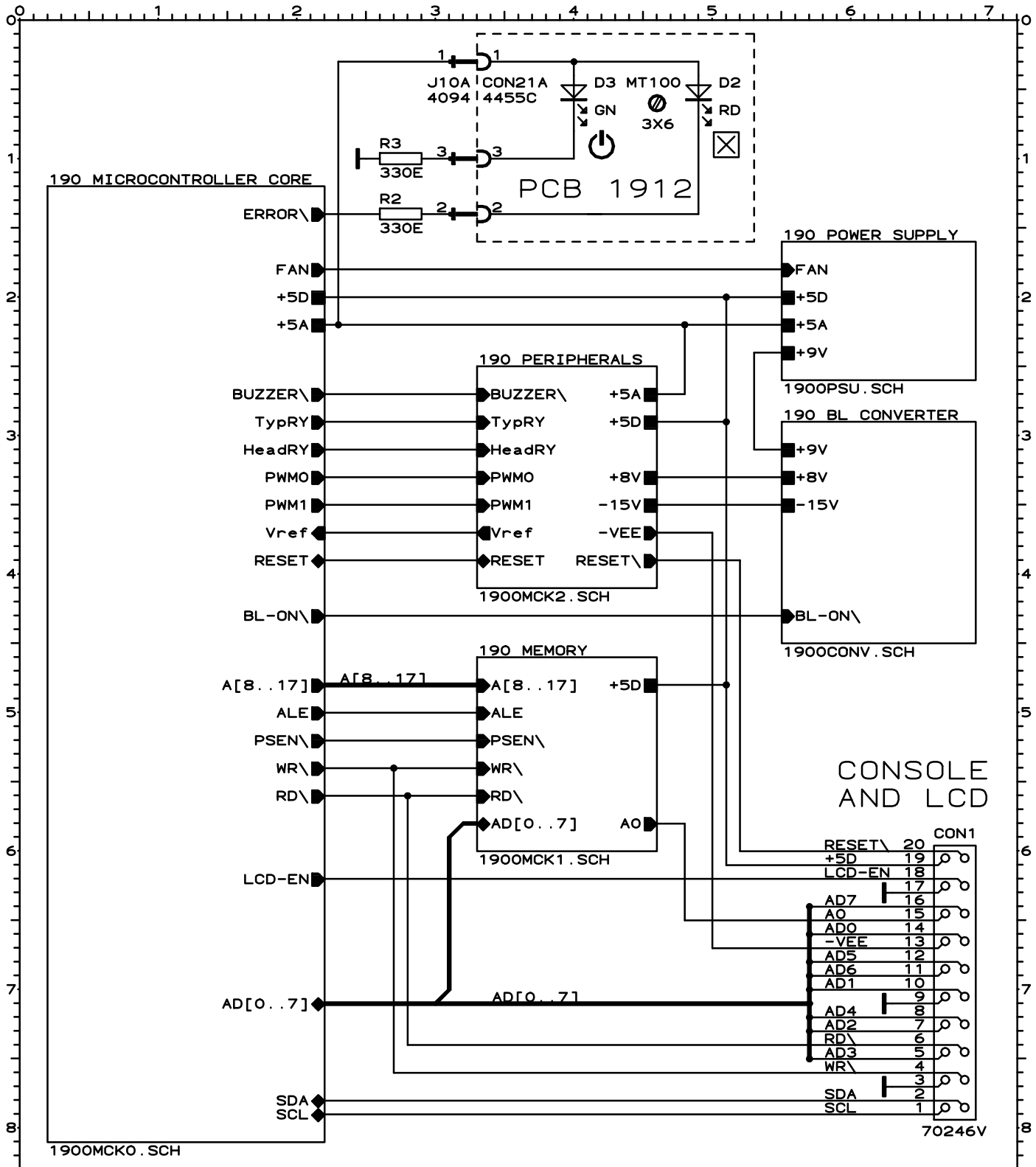
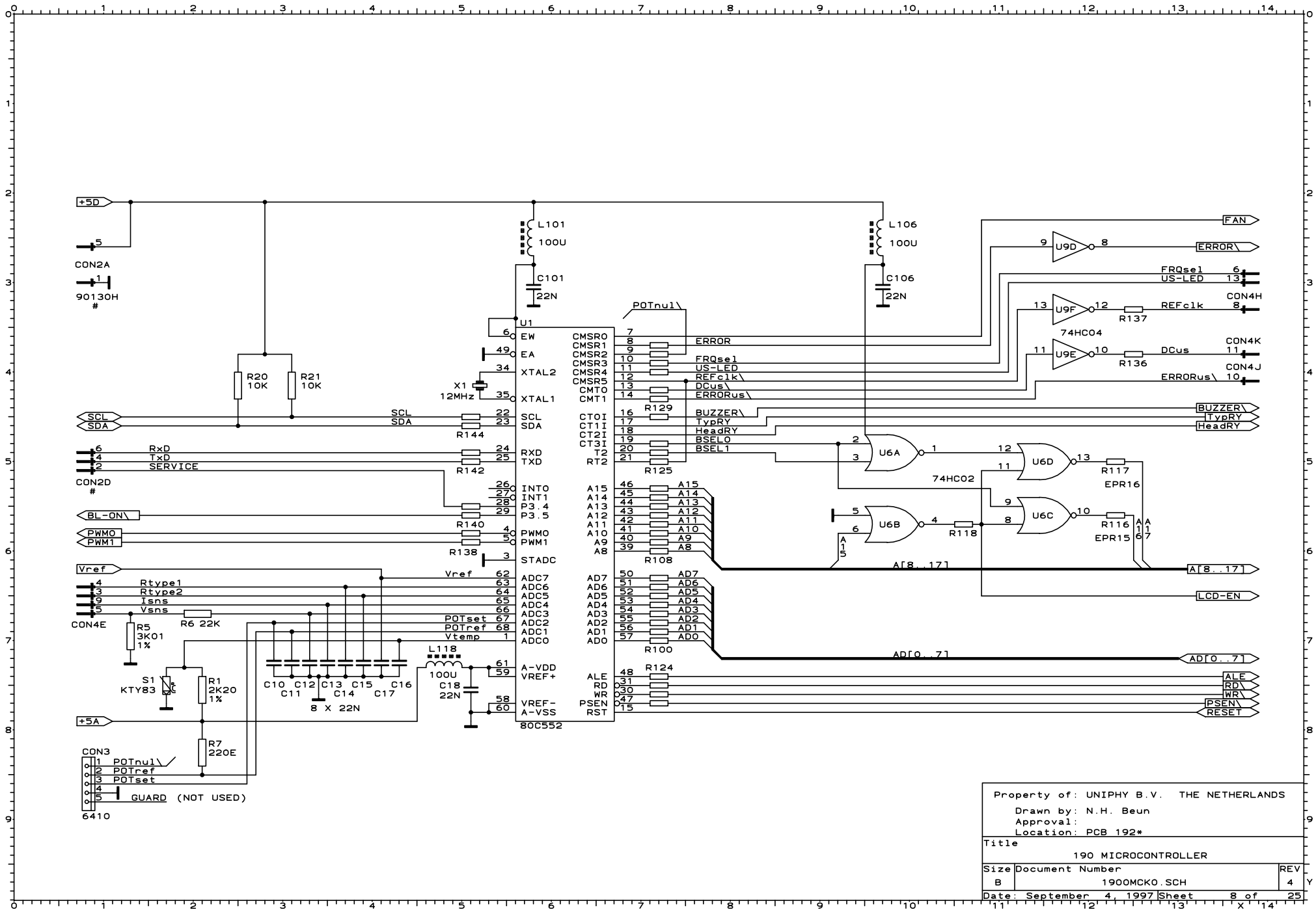


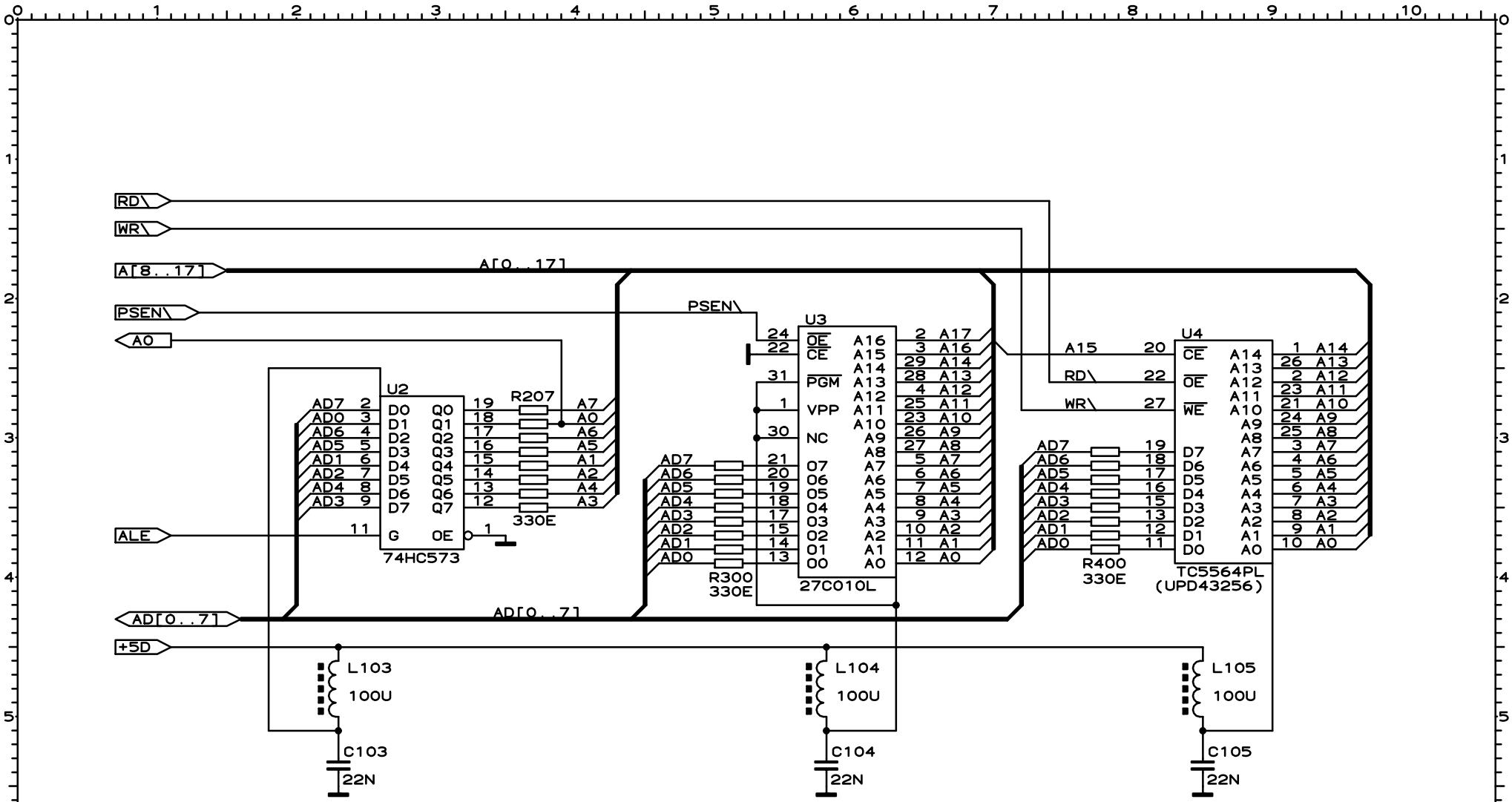
Property of: UNIPHY B.V. THE NETHERLANDS
Drawn by: N.H. Beun
Approval:
Location: 192*

Title: 190 MAIN PCB 192*

Size	Document Number	REV
D	1900PCB2.SCH	4

Date: September 4, 1997 Sheet 7 of 25


+5D
CON2A
90130H
#
L101
100U
C101
22N
L106
100U
C106
22N
U1
80C552
POTnul\
R20
10K
R21
10K
X1
12MHz
SCL
SDA
R144
RxD
TxD
SERVICE
CON2D
R142
BL-ON\
PWMO
PWM1
R140
R138
STADC
Vref
Rtype1
Rtype2
Isns
Vsns
CON4E
R6 22K
R5
3K01
1%
S1
KTY83
R1
2K20
1%
+5A
R7
220E
CON3
POTnul\
POTref
POTset
GUARD (NOT USED)
6410
C10 C11 C12 C13 C14 C15 C16 C17
8 X 22N
L118
100U
C18
22N
EW
EA
XTAL2
XTAL1
INT0
INT1
P3.4
P3.5
PWM0
PWM1
A-VDD
VREF+
VREF-
A-VSS
CMSR0
CMSR1
CMSR2
CMSR3
CMSR4
CMSR5
CMT0
CMT1
CT0I
CT1I
CT2I
CT3I
T2
RT2
R129
R125
ERROR
FRQsel
US-LED
REFclk\
DCus\
ERRORus\
BUZZER\
TypRY
HeadRY
BSEL0
BSEL1
A15
A14
A13
A12
A11
A10
A9
A8
R108
A[8..17]
ADC7
ADC6
ADC5
ADC4
ADC3
ADC2
ADC1
ADC0
POTset
POTref
Vtemp
AD7
AD6
AD5
AD4
AD3
AD2
AD1
AD0
R100
AD[0..7]
R124
ALE
RD
WR
PSEN
RST
U6A
U6B
U6C
U6D
74HC02
U9D
U9E
U9F
74HC04
R137
R136
R118
R117
R116
EPR16
EPR15
FAN
ERROR\
FRQsel
US-LED
REFclk
DCus
ERRORus\
CON4H
CON4K
CON4J
BUZZER\
TypRY
HeadRY
A[8..17]
LCD-EN
AD[0..7]
ALE
RD\
WR\
PSEN\
RESET
Property of: UNIPHY B.V. THE NETHERLANDS
Drawn by: N.H. Beun
Approval:
Location: PCB 192*
Title
190 MICROCONTROLLER
Size B
Document Number 1900MCK0.SCH
REV 4
Date: September 4, 1997
Sheet 8 of 25

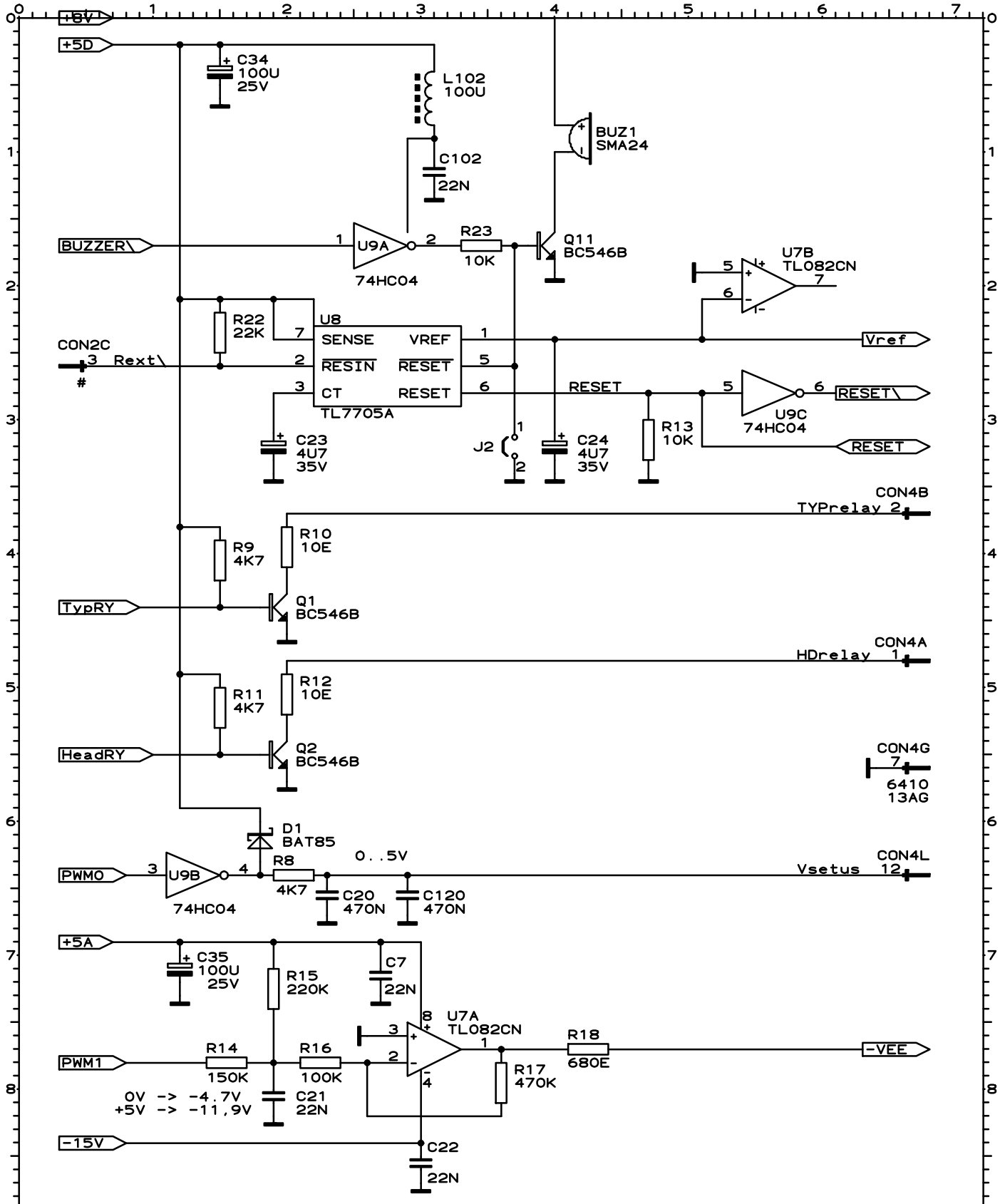


Property of: UNIPHY B.V. THE NETHERLANDS
Drawn by: N.H. Beun
Approval:
Location: PCB 192*

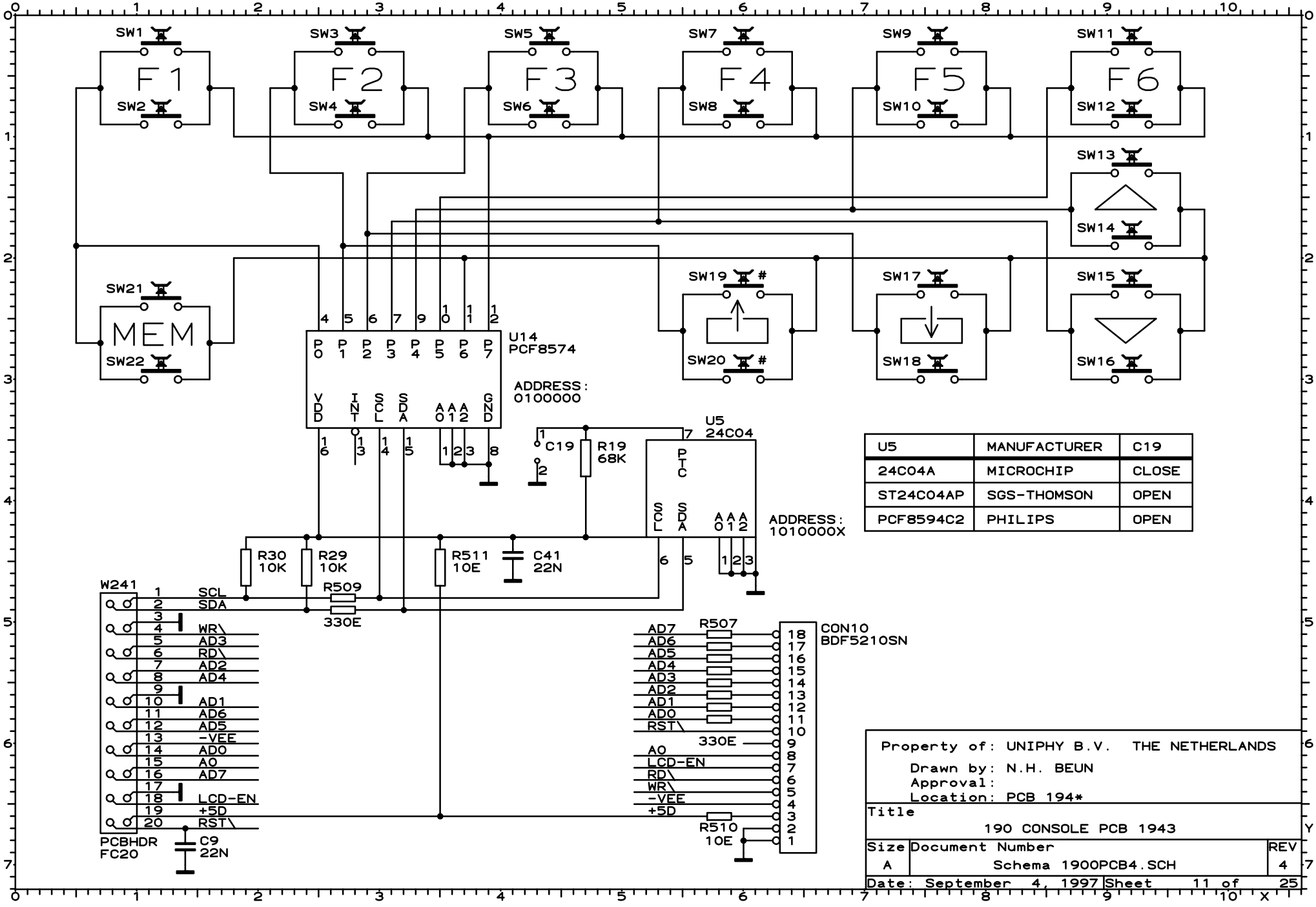
Title: 190 MEMORY

Size	Document Number	REV
A	1900MCK1.SCH	4.1

Date: August 28, 1998 Sheet 9 of 25



Property of: UNIPHY B.V. THE NETHERLANDS		
Drawn by: N.H. Beun		
Approval:		
Location: PCB 192*		
Title: 190 PERIPHERALS		
Size: D	Document Number: 1900MCK2.SCH	REV: 4
Date: September 4, 1997	Sheet 10 of 25	



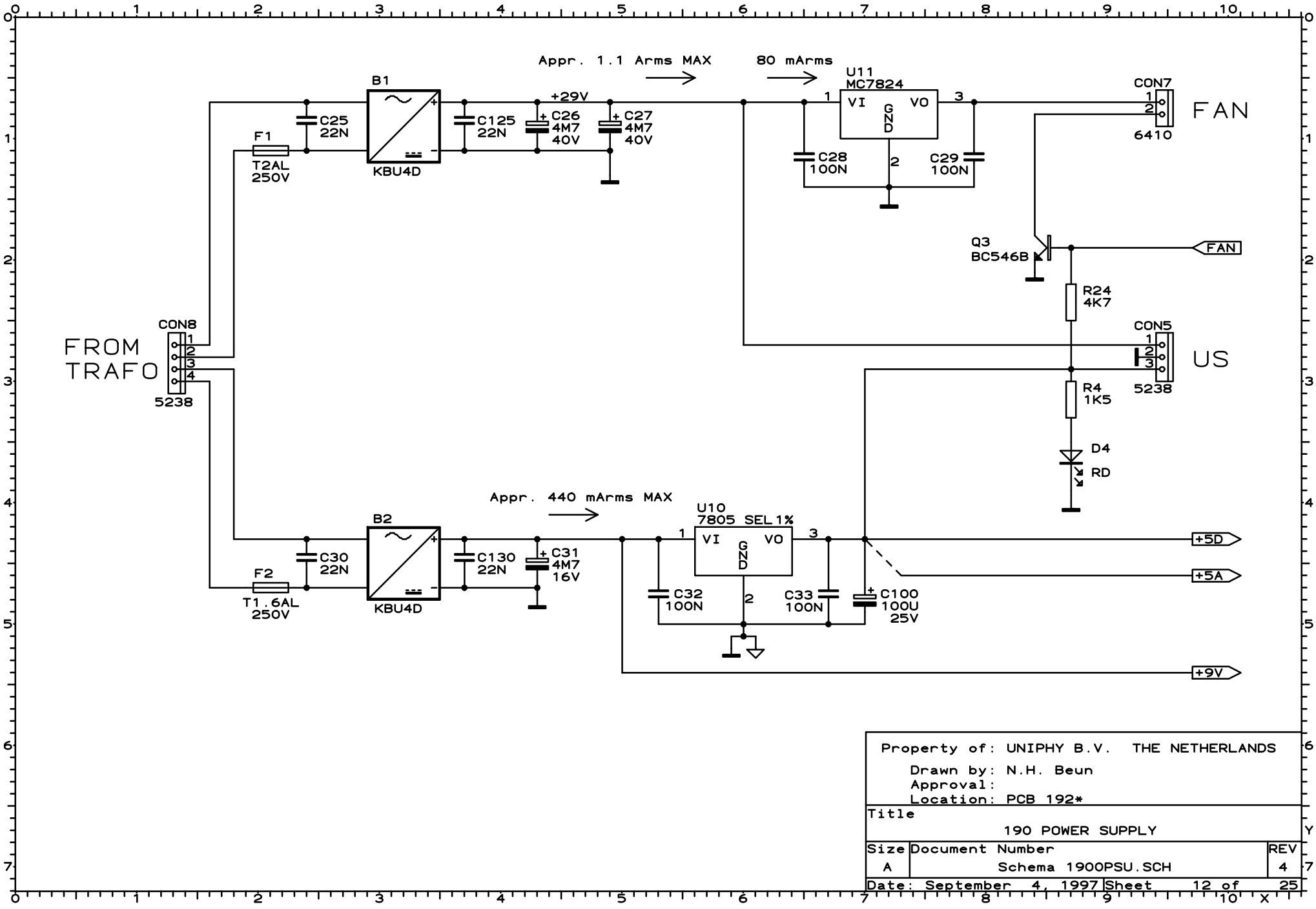
U5	MANUFACTURER	C19
24C04A	MICROCHIP	CLOSE
ST24C04AP	SGS-THOMSON	OPEN
PCF8594C2	PHILIPS	OPEN

Property of: UNIPHY B.V. THE NETHERLANDS
Drawn by: N.H. BEUN
Approval:
Location: PCB 194*

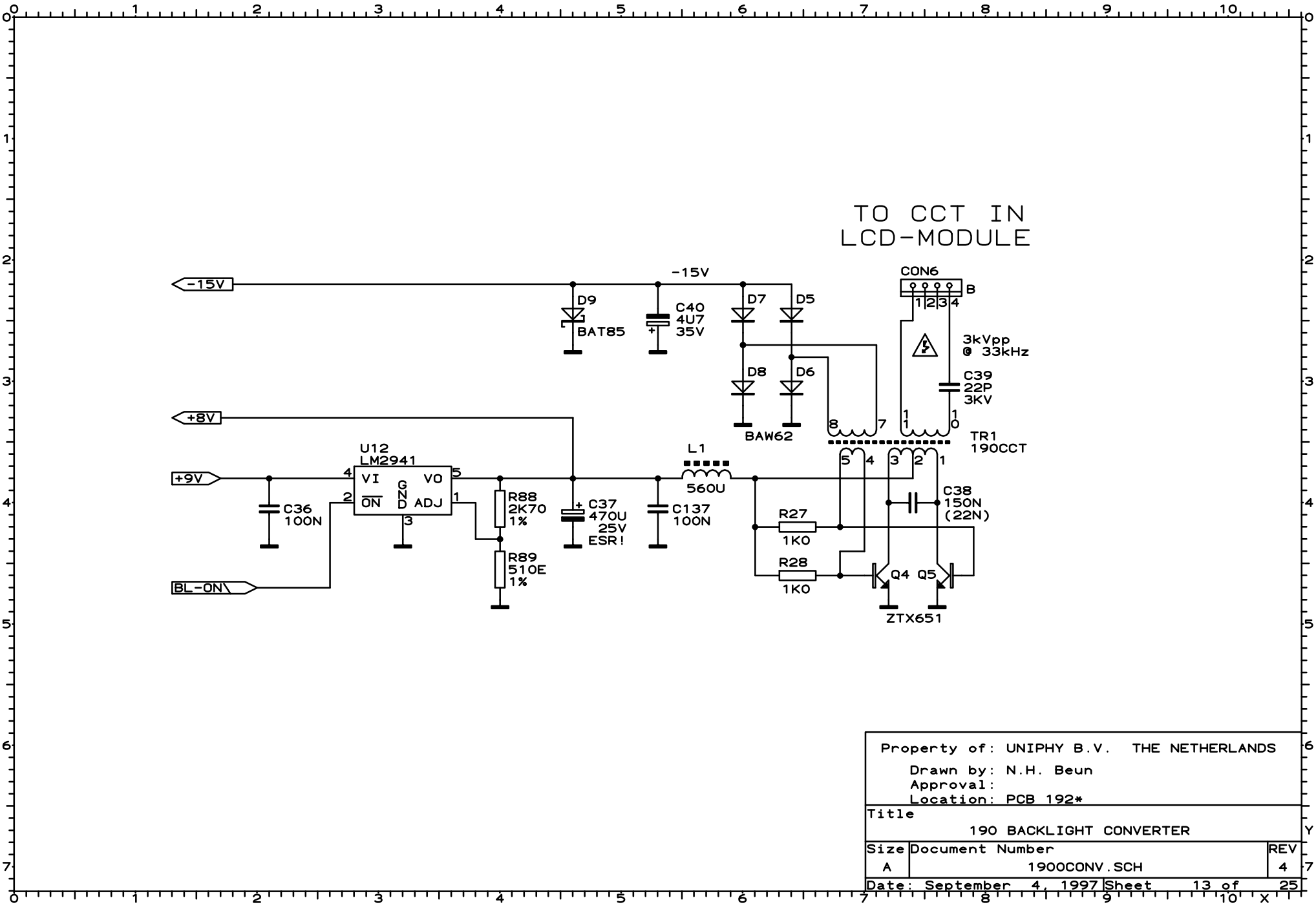
Title
190 CONSOLE PCB 1943

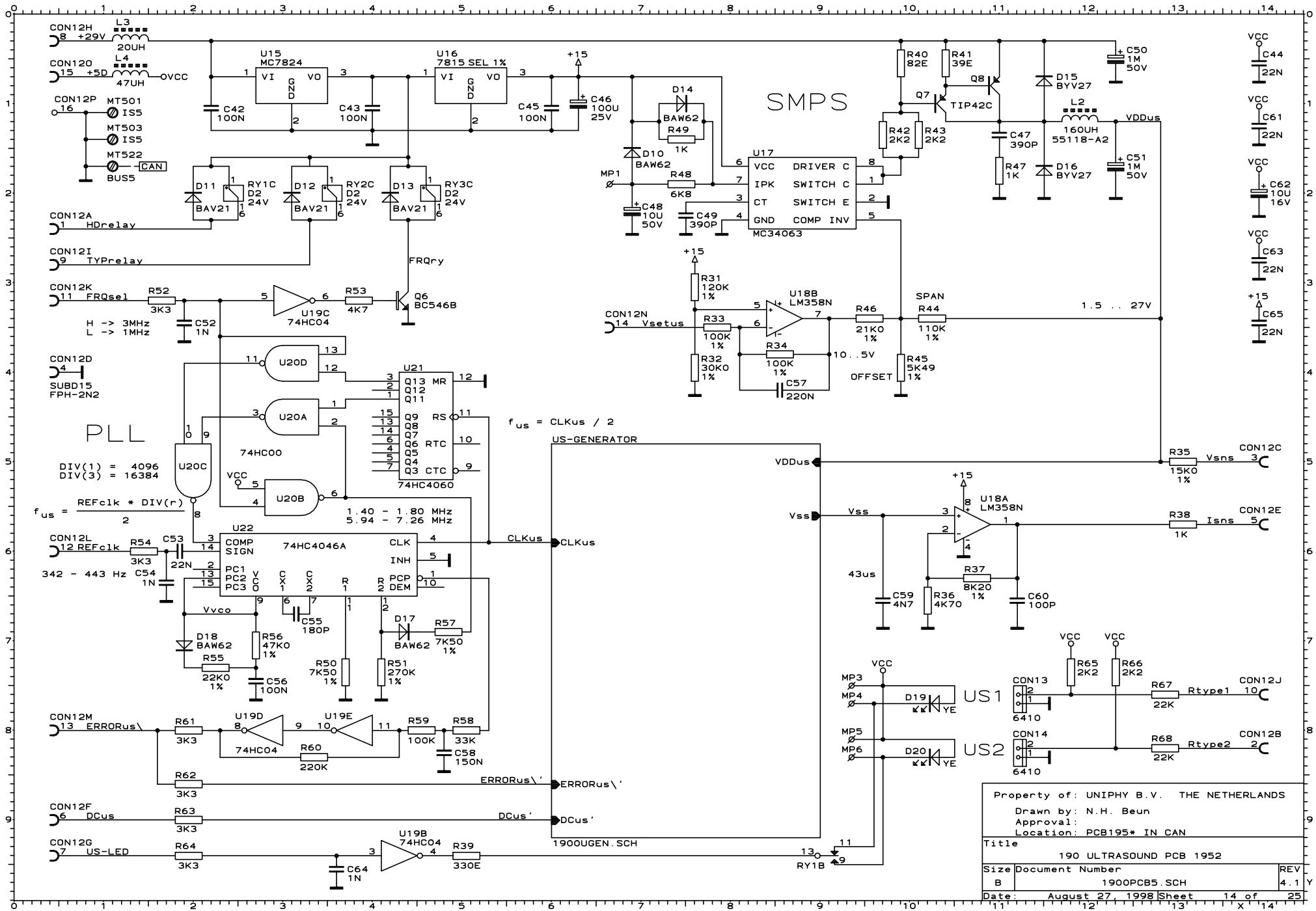
Size	Document Number	REV
A	Schema 1900PCB4.SCH	4

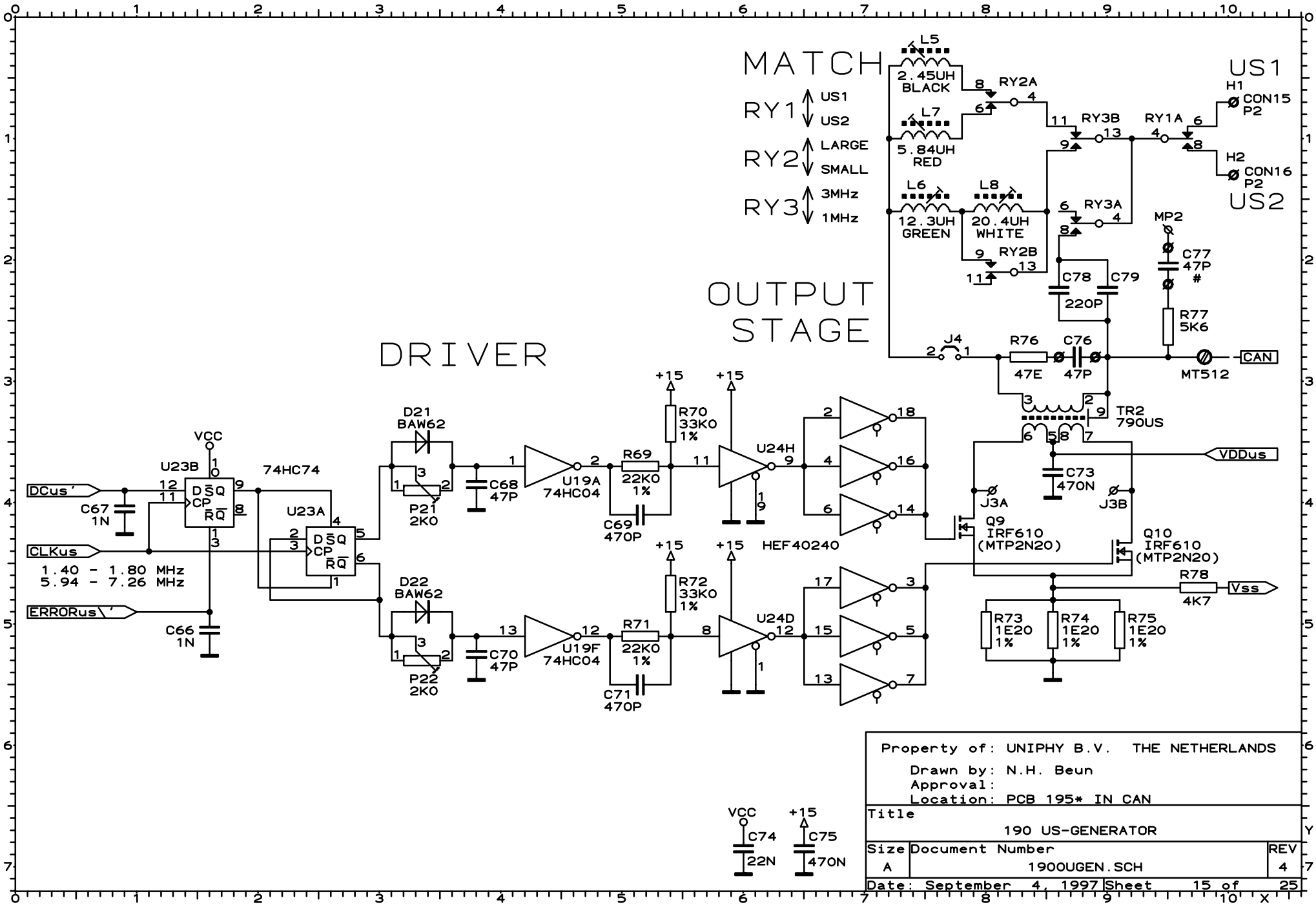
Date: September 4, 1997 Sheet 11 of 25



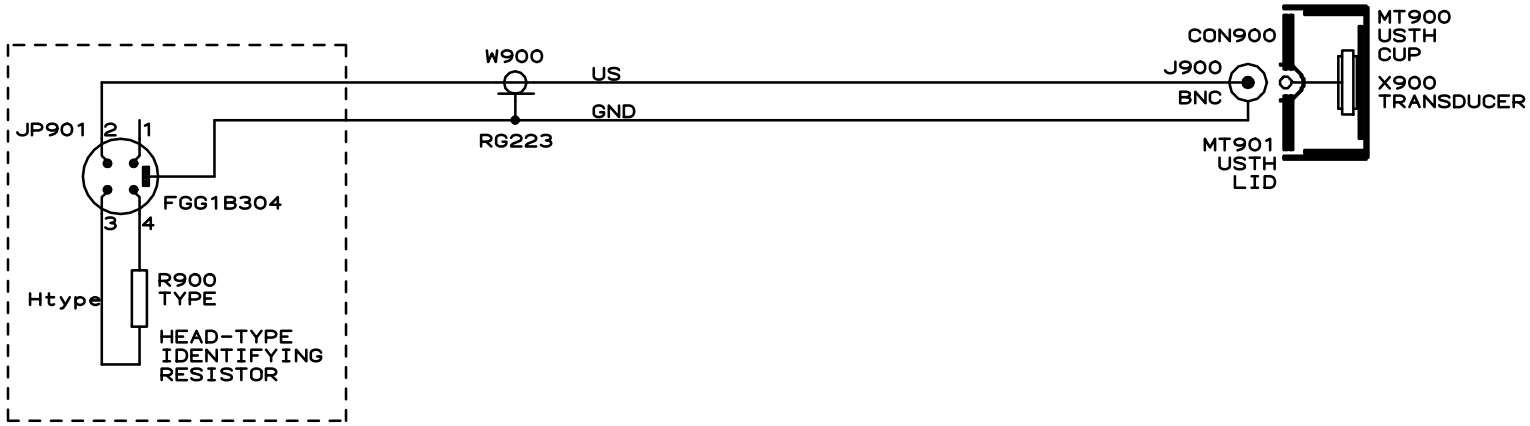
Property of:	UNIPHY B.V. THE NETHERLANDS
Drawn by:	N.H. Beun
Approval:	
Location:	PCB 192*
Title	190 POWER SUPPLY
Size	A
Document Number	Schema 1900PSU.SCH
REV	4
Date:	September 4, 1997
Sheet	12 of 25


TO CCT IN
LCD-MODULE
-15V
-15V
D9
BAT85
C40
4U7
35V
D7
D5
D8
D6
BAW62
CON6
B
1 2 3 4
3kVpp
@ 33kHz
C39
22P
3KV
TR1
190CCT
+8V
+9V
BL-ON\
U12
LM2941
VI
ON
GND
VO
ADJ
C36
100N
R88
2K70
1%
R89
510E
1%
C37
470U
25V
ESR!
L1
560U
C137
100N
R27
1K0
R28
1K0
C38
150N
(22N)
Q4 Q5
ZTX651
Property of: UNIPHY B.V. THE NETHERLANDS
Drawn by: N.H. Beun
Approval:
Location: PCB 192*
Title
190 BACKLIGHT CONVERTER
Size
A
Document Number
1900CONV.SCH
REV
4
Date: September 4, 1997
Sheet 13 of 25


SMPS
PLL
MC34063
74HC4046A
74HC4060
74HC00
74HC04
US-GENERATOR
1900UGEN.SCH
US1
US2
Property of: UNIPHY B.V. THE NETHERLANDS
Drawn by: N.H. Beun
Approval:
Location: PCB195* IN CAN
Title
190 ULTRASOUND PCB 1952
Size B
Document Number 1900PCB5.SCH
REV 4.1
Date: August 27, 1998
Sheet 14 of 25


MATCH
RY1 US1 US2
RY2 LARGE SMALL
RY3 3MHz 1MHz
L5
2.45UH
BLACK
L7
5.84UH
RED
L6
12.3UH
GREEN
L8
20.4UH
WHITE
RY2A
RY3B
RY1A
RY3A
RY2B
US1
H1
CON15
P2
H2
CON16
P2
US2
MP2
C77
47P
#
C78
C79
220P
R77
5K6
J4
R76
47E
C76
47P
CAN
MT512
TR2
790US
VDDus
C73
470N
J3A
J3B
Q9
IRF610
(MTP2N20)
Q10
IRF610
(MTP2N20)
R78
4K7
Vss
R73
1E20
1%
R74
1E20
1%
R75
1E20
1%
OUTPUT
STAGE
DRIVER
VCC
U23B
74HC74
U23A
DCus'
CLKus
1.40 - 1.80 MHz
5.94 - 7.26 MHz
ERRORus\'
C67
1N
C66
1N
D21
BAW62
D22
BAW62
P21
2K0
P22
2K0
C68
47P
C70
47P
U19A
74HC04
U19F
74HC04
R69
22K0
1%
R71
22K0
1%
C69
470P
C71
470P
+15
R70
33K0
1%
R72
33K0
1%
U24H
U24D
HEF40240
C74
22N
C75
470N
Property of: UNIPHY B.V. THE NETHERLANDS
Drawn by: N.H. Beun
Approval:
Location: PCB 195* IN CAN
Title
190 US-GENERATOR
Size
A
Document Number
1900UGEN.SCH
REV
4
Date: September 4, 1997
Sheet 15 of 25

090W01



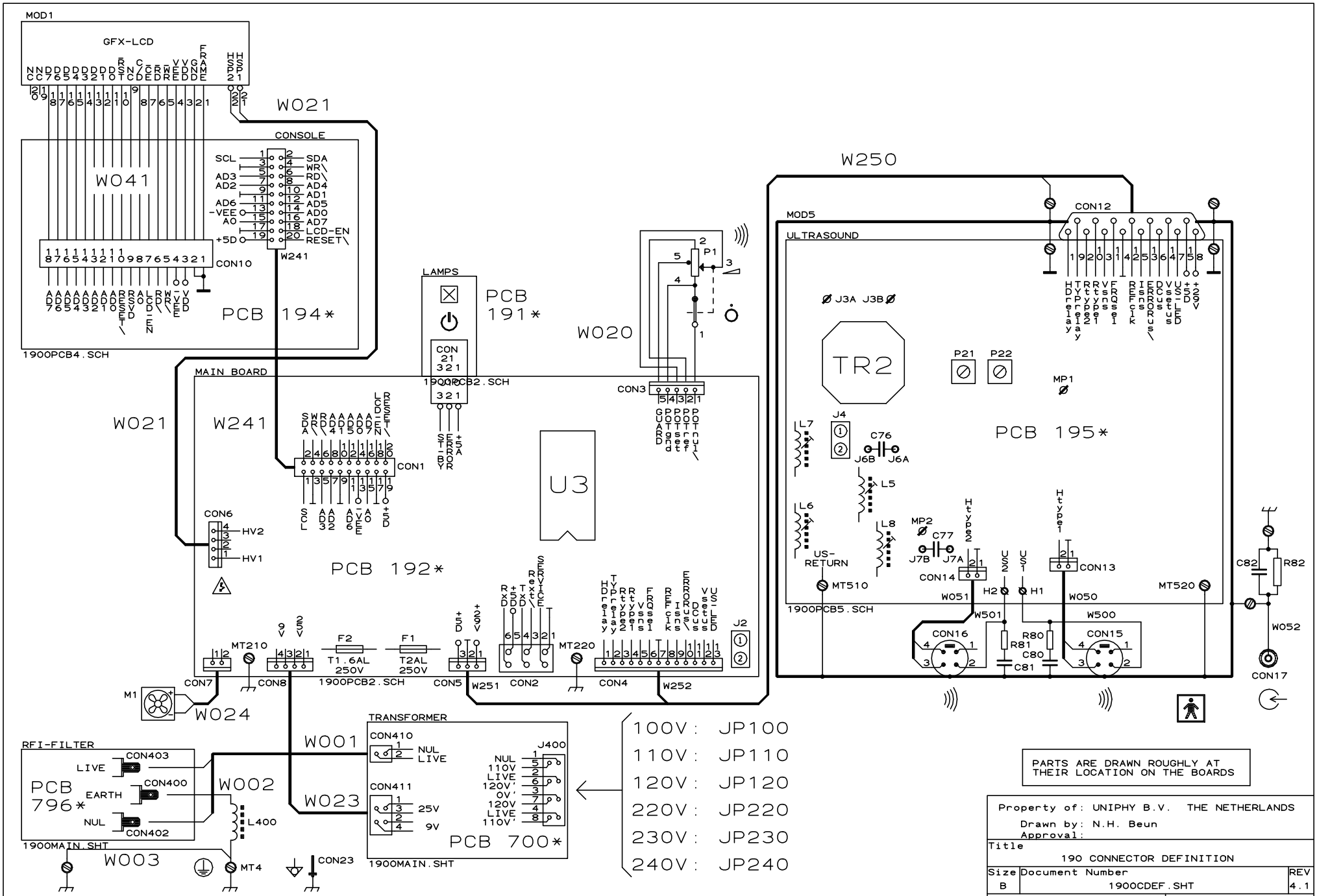
TYPE	R900	X900	ERA
091	680E	D13	1cm²
092	2K20	D25	4cm²

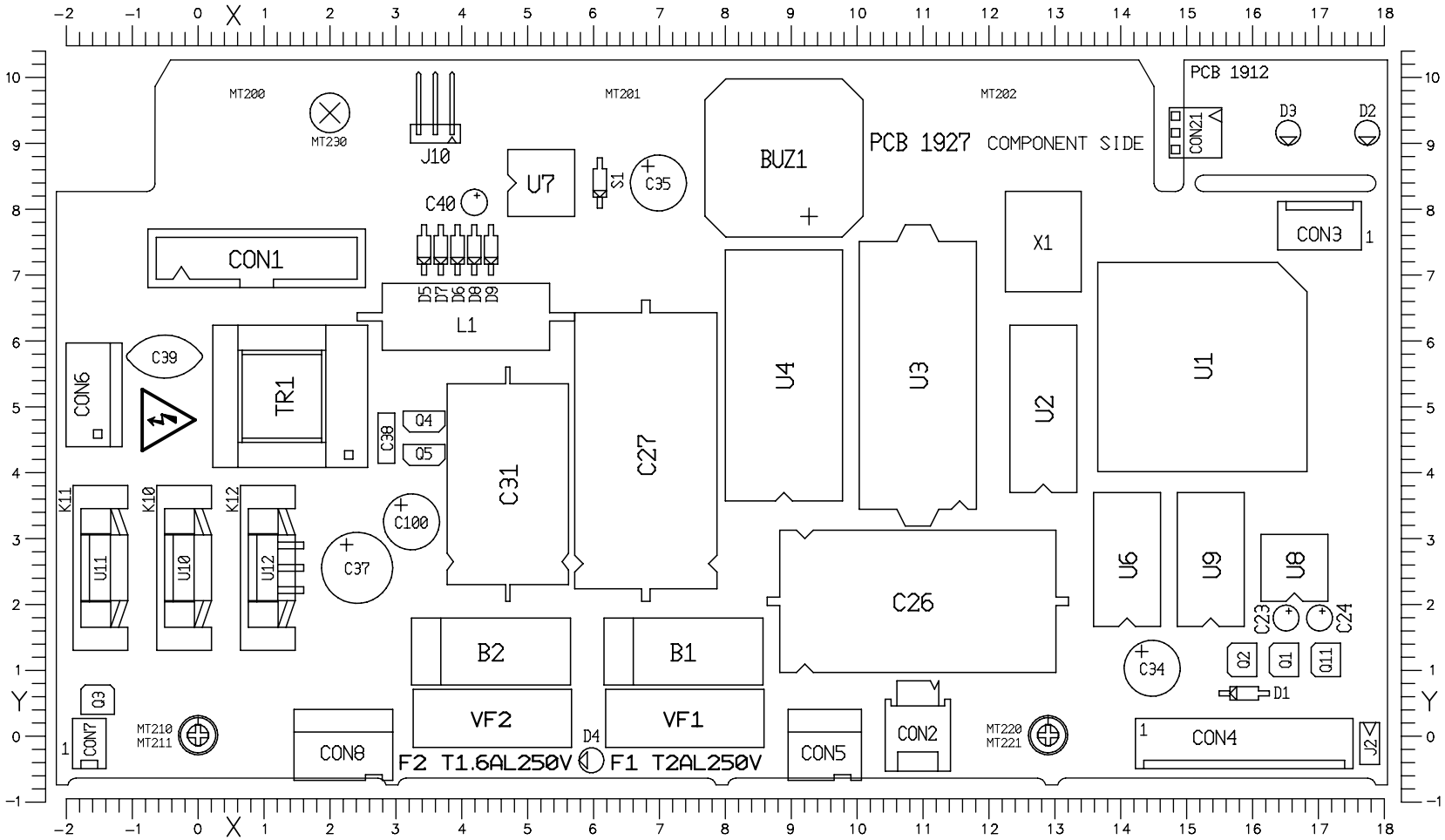
Property of: UNIPHY B.V. THE NETHERLANDS
Drawn by: N.H. Beun
Approval:
Location: UTH9*

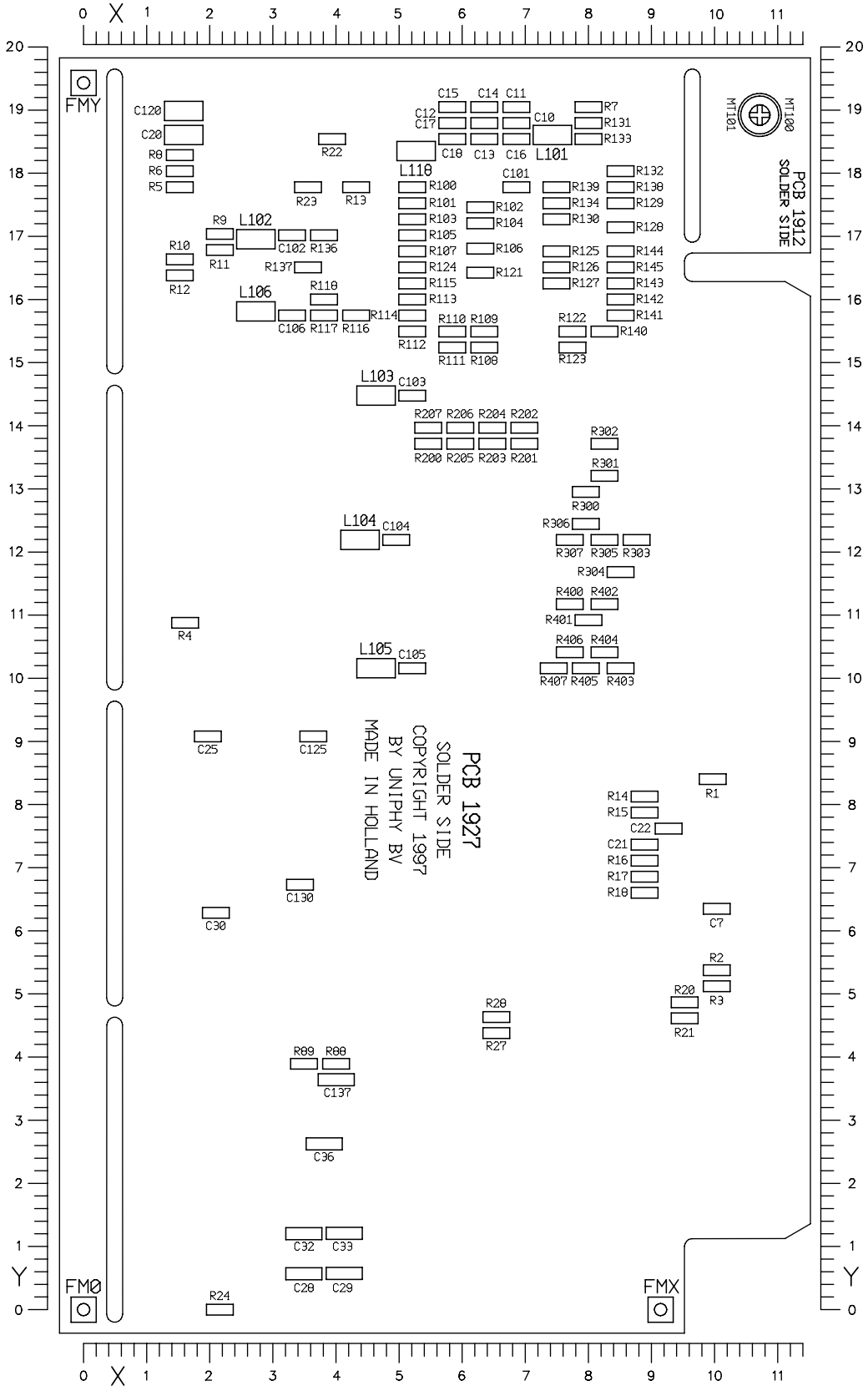
Title
190 US TREATMENT HEAD 91/92

Size	Document Number	REV
A	1900USPB.SCH	4

Date: September 4, 1997 | Sheet 16 of 25


MOD1
GFX-LCD
W021
CONSOLE
W041
SCL
SDA
AD3
WR\
AD2
RD\
AD4
AD1
AD6
AD5
-VEE
AD0
AO
AD7
LCD-EN
+5D
RESET\
W241
CON10
PCB 194*
1900PCB4.SCH
LAMPS
PCB 191*
W020
P1
CON3
MAIN BOARD
W021
W241
CON1
U3
CON6
HV2
HV1
PCB 192*
MT210
F2
T1.6AL 250V
F1
T2AL 250V
1900PCB2.SCH
CON7
CON8
CON5
W251
CON2
MT220
CON4
W252
J2
M1
W024
W250
MOD5
ULTRASOUND
CON12
TR2
P21
P22
MP1
J3A
J3B
J4
C76
J6B
J6A
L7
L5
L6
L8
MP2
C77
J7B
J7A
US-RETURN
MT510
CON14
W051
H2
H1
W050
MT520
PCB 195*
1900PCB5.SCH
CON16
R80
R81
C80
C81
CON15
W500
W501
CON13
C82
R82
W052
CON17
TRANSFORMER
CON410
NUL
LIVE
CON411
25V
9V
J400
PCB 700*
1900MAIN.SHT
W001
W002
W023
W003
RFI-FILTER
CON403
CON400
CON402
PCB 796*
L400
MT4
CON23
1900MAIN.SHT
100V: JP100
110V: JP110
120V: JP120
220V: JP220
230V: JP230
240V: JP240
PARTS ARE DRAWN ROUGHLY AT THEIR LOCATION ON THE BOARDS
Property of: UNIPHY B.V. THE NETHERLANDS
Drawn by: N.H. Beun
Approval:
Title
190 CONNECTOR DEFINITION
Size B
Document Number 1900CDEF.SHT
REV 4.1
Date: August 27, 1998
Sheet 17 of 25


PCB 1912
PCB 1927 COMPONENT SIDE
MT200
MT201
MT202
MT230
J10
U7
S1
C35
BUZ1
C40
CON1
D5
D7
D6
D8
D9
L1
X1
CON3
CON21
D3
D2
C39
CON6
TR1
C38
Q4
Q5
C31
C27
U4
U3
U2
U1
K11
K10
K12
U11
U10
U12
C100
C37
C26
U6
U9
U8
C23
C24
B2
B1
C34
Q2
Q1
Q11
D1
Q3
CON7
MT210
MT211
VF2
VF1
D4
CON8
F2 T1.6AL250V
F1 T2AL250V
CON5
CON2
MT220
MT221
CON4
J2
X
Y


PCB 1927
SOLDER SIDE
COPYRIGHT 1997
BY UNIPHY BV
MADE IN HOLLAND
PCB 1912
SOLDER SIDE
MT100
MT101
FMY
FM0
FMX
L101
L102
L103
L104
L105
L106
L110
C10
C11
C12
C13
C14
C15
C16
C17
C18
C20
C25
C30
C32
C33
C36
C101
C102
C103
C104
C105
C106
C125
C130
C137
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R20
R21
R22
R23
R24
R27
R28
R99
R100
R101
R102
R103
R104
R105
R106
R107
R108
R109
R110
R111
R112
R113
R114
R115
R116
R117
R118
R120
R121
R122
R123
R124
R125
R126
R127
R129
R130
R131
R132
R133
R134
R136
R137
R139
R140
R141
R142
R143
R144
R145
R200
R201
R202
R203
R204
R205
R206
R207
R300
R301
R302
R303
R304
R305
R306
R307
R400
R401
R402
R403
R404
R405
R406
R407
C120
C137
C28
C29

Phyaction 190
Ultrasound treatment head installation procedure

Valid from SW-version 3.01

In order to tune a treatment head to the Phyaction 190, it is necessary to take the following steps:

1) Turn off the Phyaction 190

2) Connect the treatment head you wish to tune to the Phyaction 190

3) Press the blue function keys number 4 and 6 (the right most blue key and the blue key third from the right) and keep them pressed

4) Turn on the Phyaction 190, while function keys 4 and 6 are pressed.
When you hear the buzzer sound, release both function keys. When you have done this correctly, you will see the screens from figure 1, followed by figure 2 (of course the version numbers can differ). When you release the keys too late, you will get an error message (error 41).

5) In the normal user screen (see figure 3) the word 'Service' will appear in the top right corner.

6) Keep the yellow key pressed, until the 'Service Menu' appears (see figure 4).

7) Now press function key 1 (Set head parameters). Figure 5 appears on the screen. If it does not appear, check if a treatment head is connected.

8) If necessary, select the desired head with function key 1. Then enter the correct head parameters, using the up and down keys and the left and right keys (function keys 3 and 4). The head parameters are on the label of the treatment head.

9) When the parameters are entered correctly you can press the Ok button (function key 5). The screen as shown in figure 6 will appear. When the Phyaction 190 detects an invalid set of parameters, the Ok key will not be accepted.

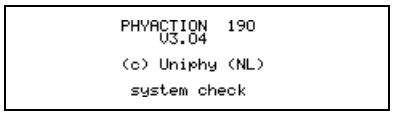


Figure 1

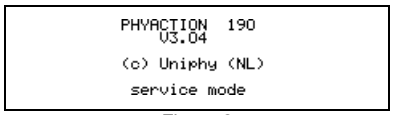


Figure 2

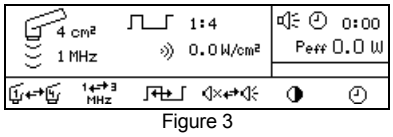


Figure 3

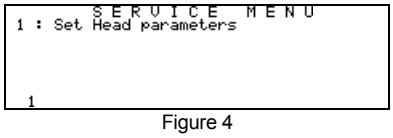


Figure 4

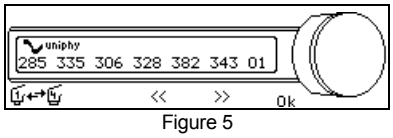


Figure 5

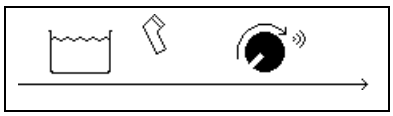


Figure 6

10) Ensure the treatment head to be dry and clean, then turn up the intensity knob. The Phyaction 190 will now tune the treatment head. The Phyaction 190 will show figure 7 during tuning.

11) When you see the screen as in figure 8, turn back the intensity knob to its zero position.

12) Put the selected treatment head in a large bowl amply filled with water (about 18°C). Keep the treatment head in such a way that the generated ultrasound cannot reflect onto the treatment head.

13) Now turn up the intensity knob (see figure 9). The Phyaction will now tune the treatment head. The Phyaction 190 will show figure 10 and 11 during tuning. The Phyaction will show if the tuning has succeeded. It shows the frequency at which it is tuning the head, followed by the message 'Done' or 'Bad'.

14) If one or two of the results are 'Bad', the tuning has not succeeded. A code representing the reason why the tuning has not succeeded, occurs in the lower right corner (see figure 12). Turn back the intensity knob to its zero position. Now wait until the service menu appears again.
Repeat the steps from step 7 (including checking of the head parameters).
When the result is still bad, contact your supplier.

15) When the treatment head is tuned on both frequencies (see figure 13), turn back the intensity knob to its zero position. Now wait until the service menu appears again.

16) Now you have tuned the treatment head to the Phyaction 190.

17) If you want to tune another treatment head, continue with step 7 and choose the other treatment head

18) Turn off the Phyaction 190 (but remember, not before the service menu has appeared)

19) Turn on the Phyaction 190 and check the contact control of the head(s) you have just tuned (see the Instructions for use).

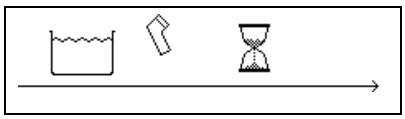


Figure 7

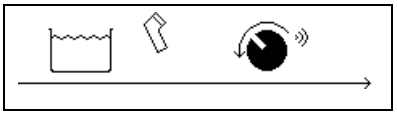


Figure 8

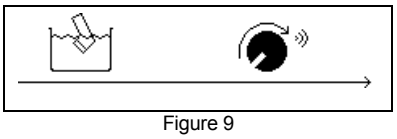


Figure 9

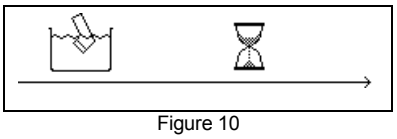


Figure 10

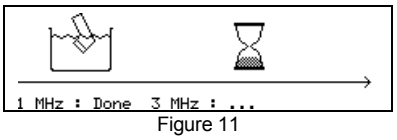


Figure 11

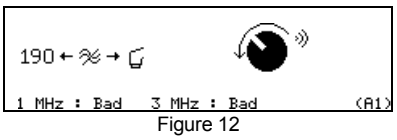


Figure 12

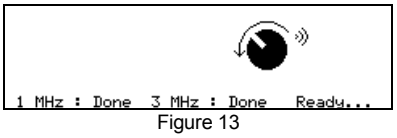


Figure 13

Short list of error numbers

Microcontroller core:

00	err_CPU	An internal CPU error is found (ALU/instructions)
01	err_IntRAM	Internal RAM error
02	err_RAM	External RAM error
03	err_Bankswitch	Bankswitching error
04	err_ROM0	Checksum error in the first part of the program ROM
05	err_ROM1	Checksum error in the second part of the program ROM

Peripherals:

06	err_CPUsfr	Special function register start-up error
07	err_CPUtimer0	Timer 0 error
08	err_ADC	AD converter time out
09	err_CPUtimers	Timer error (timer 0, 1 or 2)

I²C bus:

10	err_I2C	General I²C error
11	err_I2C_TimeOut	Time out of the I²C bus
12	err_I2C_ReadErr	I²C Error during read
14	err_I2C_WriteErr	I²C Error during write

User interface:

20	err_LCD	General LCD error
21	err_LCD_TimeOut	LCD time out error
27	err_Ser_TimeOut	Serial port time out

E²PROM errors:

30	err_E2PROM	General E²PROM error
31	err_E2PROM_Checksum	Checksum error in the E²PROM
32	err_E2PROM_Blank	E²PROM completely blank

Keyboard:

40	err_Keyboard	General keyboard error
41	err_KeyPressed	Key pressed during power up

Internal voltages:

50	err_Voltage	General error voltage inputs
51	err_Vsense0	Vus too high at start-up
52	err_Vsense1	Vus too low during reference test
53	err_Vsense2	Vus too high after discharge
54	err_VPotRef	PotRef value incorrect
55	err_VPotNul	PotNul active while Pot_US > 10
56	err_VRef	Vref value incorrect
57	err_Vddus	Vddus too high
58	err_Errorhead	Error head or unknown head found at start-up
59	err_VIsns	Isns too high during no ultrasound

Phase locked loop:

60	err_PLL_Lock	PLL out of lock

Internal temperature:

70	err_VTemp	Internal temperature too high

Software:
90 err_End_Of_Main Unexpected end of program

Acoustic error messages

If an error is found, four different types of acoustic signals can be given:

- 2 sec. beep : Non-critical error during normal use, to be corrected by the user.
- 1/2 sec. beep : Critical error, not of the CPU, that can be displayed.
- 1/2 sec. + 3 short beeps : Time out of the LCD (Error 21), an error that normally cannot be displayed
- 6 short beeps : Critical CPU error (00 to 09). The microcontroller tries to show this error on the LCD display.

List of errors with possible causes

Nr.	Name	Description	Val	Comment
1. Microcontroller core				
00	err_CPU	An error is found in the ALU or the instructions of the microcontroller. Check the microcontroller and the software.	00 xx	If value differs from 00, an incorrect internal register bank is addressed. Six short beeps will sound.
01	err_IntRAM	An error is found in the internal RAM of the microcontroller. Probably the microcontroller needs to be replaced. Otherwise check the software.	xx	Value indicates at which memory location the error is found. Six short beeps will sound.
02	err_RAM	An error is found in the external RAM. Check the RAM and the data/address lines.	xx	Value indicates in which 256 byte block the error is found. Six short beeps will sound.
03	err_Bankswitch	Bankswitching of the program ROM is not functioning properly. Check the bankswitching hardware and the appropriate processor lines.	01	Value shows the bank number (At present always 01). Six short beeps will sound.
04	err_ROM0	Incorrect checksum in the first 32 kByte of the EPROM. Check the EPROM contents and the	xx	Value contains the LSB of the 16 bit checksum

Nr.	Name	Description	Val	Comment
		data/address lines.		Six short beeps will sound.
05	err_ROM1	Incorrect checksum in the second 32 kByte of the EPROM. Check the EPROM contents and the data/address lines.	80	Six short beeps will sound.
2. Peripherals				
06	err_CPUsfr	The reset values of the Special function registers (sfr) differ from the expected values. Check the microcontroller and the software.	00 01 02 03 04 05 06 07 08 09 0A	sfr: PCON sfr: IEN1 sfr: IP0 sfr: IP1 sfr: ADCON sfr: TCON sfr: TMOD sfr: TM2CON sfr: CTCON sfr: TM2IR sfr: S0CON Six short beeps will sound.
07	err_CPUtimer0	Timing of timer 0 is incorrect. Check the microcontroller and the software.	xx	Value gives an estimate of the number of times timer 0 has caused an interrupt since a 10 msec flag was set. Six short beeps will sound.
08	err_ADC	No interrupt from the AD converter. Check the microcontroller and the software.	00	Six short beeps will sound.
09	err_CPUtimers	Improper functioning of Timer 0, 1, or 2. Check the microcontroller and the software.	00 01 02	timer 0 timer 1 timer 2 Six short beeps will sound.
3. I²C bus				
10	err_I2C	General I²C error for internal use. (Mask for detecting an I²C error).		Only for internal use.
11	err_I2C_TimeOut	Time out of an I²C device. Check the addressed device. Check the complete I²C bus and the microcontroller if Value = 40 (the first device accessed).		The user sees this message if an I²C error occurs. Value contains the address of the device that caused the time out.

Nr.	Name	Description	Val	Comment
			40 41 A0 A1	I/O expander (write) I/O expander (read) E²PROM (write) E²PROM (read)
12	err_I2C_ReadErr	Only for testing purposes.		
13	err_I2C_WriteErr	Only for testing purposes.		
4. User interface				
20	err_LCD	General LCD error for internal use. (Mask for detecting an LCD error).		Only for internal use.
21	err_LCD_TimeOut	LCD communication error. Check the LCD, the connections (data / address lines) to the LCD, the selection logic and the microcontroller.	xx	Value contains the status of the LCD. One longer beep and three short beeps will sound.
27	err_Ser_TimeOut	RS-232 communication error. Check the microcontroller and the software.		
5. E²PROM errors				
30	err_E2PROM	General E²PROM error for internal use. (Mask for detecting an LCD error).		Only for internal use.
31	err_E2PROM_Checksum	Incorrect E²PROM checksum. Probably the unit is switched off during a write to the E²PROM. The checksum will be corrected automatically. If this error occurs regularly check the E²PROM.	xx	Value shows the checksum as stored in the E²PROM.
32	err_E2PROM_Blank	A signature that should be stored in the E²PROM is not found and the software erases the E²PROM. This error always occurs in a totally new unit. If this error occurs in an existing unit, the E²PROM should be checked. If considered appropriate, check the software.	00	This error will always show if a new keyboard PCB is installed or the E²PROM is replaced. In those cases the E²PROM will be empty so no signature will be found. Otherwise this error may never occur.
6. Keyboard				
40	err_Keyboard	General keyboard error for internal use. (Mask for detecting a keyboard error).		For internal use only.
41	err_KeyPressed	A key action is detected during power up.	xx	Value contains the number of the detec-

Nr.	Name	Description	Val	Comment
		If no key is pressed during power up, check the keyboard and the keyboard PCB.		ted key. This function also discourages the user if trying to enter the service menu.
7. Internal voltages				
50	err_Voltage	General voltage error for internal use. (Mask for detecting an internal voltage error).		For internal use only.
51	err_Vsense0	Vus is too high (> 3.0V) at power up. Check the SMPS in the ultrasound unit. Check the PWM of the microcontroller.	xx	Value represents the measured voltage: Hexadecimal representation of the measured voltage * 10 (so at 3.5V: decimal 35 -> 23h).
52	err_Vsense1	Vus is too low (< 23.5V) at the reference value. Check the SMPS in the ultrasound unit. Check the connections between main PCB and ultrasound unit. Check the power supplies. Check the PWM.	xx	Value represents the measured voltage: Hexadecimal representation of the measured voltage * 10 (so at 22.5V: decimal 225 -> E1h).
53	err_Vsense2	Vus too high after discharge. (> 17.0V). Check the SMPS in the ultrasound unit. Check the PWM.	xx	Value represents the measured voltage: Hexadecimal representation of the measured voltage * 10 (so at 22.5V: decimal 225 -> E1h).
54	err_VPotRef	The value of VPotRef is outside its limits (< 3.75V = BFh or > 4.40V = E0h). Check the wiring of the intensity potentiometer.	xx	Value is the (8-bit) measured voltage of PotRef.
55	err_VPotNul	The intensity potentiometer switch indicates that the potentiometer should be at zero, but the measured voltage is too high (> 0.19V = 0Ah). Check the wiring of the potentiometer. Check the processor lines.	xx	Value is the (8-bit) measured voltage of the intensity potentiometer.
56	err_VRef	The reference voltage is outside its limits (< 2.39V = 79h or > 2.63V = 86h).	xx	Value is the (8-bit) measured voltage of Vref.

Nr.	Name	Description	Val	Comment
		Check the reset circuit. Check the ADC of the micro-controller.		
57	err_Vddus	The ultrasound voltage is too high (> 28.5V). Check the SMPS in the ultrasound unit.	xx	Value represents the measured voltage: Hexadecimal representation of the measured voltage (so at 29.3V: decimal 29 -> 1Dh).
58	err_Errorhead	During self test an unknown head is detected. Check for an unknown head being connected. Check the head type detection hardware.	01 10	Unknown head type in the right output. Unknown head type in the left output.
59	err_VIsns	Isns is too high if no ultrasound is produced (V > 0.05V). Check the power stage in the ultrasound unit.	xx	Value is the (8-bit) measured voltage of Vusi. (so 0.05V -> 02h).
8. Phase locked loop				
60	err_PLL_Lock	The PLL in the ultrasound unit is out of lock. Check RefClock and check the PLL circuit in the ultrasound unit. Check timer 2 of the microcontroller.	00 xx	If value = 0, the error is probably detected during self test. If value > 0 the error is found during contact rate measurement.
9. Internal temperature				
70	err_VTemp	The temperature in the unit is too high (> 65°C = 60h). Try to detect the part that produces too much heat.	xx	Value is the (8-bit) measured voltage of the temperature. (65°C = 60h)
10. Software				
90	err_End_Of_Main	The software has found an abnormal end of program flow. Check the software. Check the EPROM and data/address lines. Check the microcontroller.	00	